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Durgin et al.

(10) **Patent No.: US 6,986,767 B2**
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(54) **MULTI-FUNCTION SURGICAL INSTRUMENT**

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(73) Assignee: **Boston Scientific SciMed, Inc.**, Maple Grove, MN (US)

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(22) Filed: **Jun. 10, 2003**

(65) **Prior Publication Data**

US 2003/0212389 A1 Nov. 13, 2003

Related U.S. Application Data

(60) Continuation of application No. 09/784,118, filed on Feb. 22, 2001, now Pat. No. 6,610,056, which is a division of application No. 09/178,570, filed on Oct. 26, 1998, now Pat. No. 6,221,039.

(51) **Int. Cl.**
A61B 18/18 (2006.01)

(52) **U.S. Cl.** **606/21**; 606/48; 607/104

(58) **Field of Classification Search** 606/21–26, 606/41, 48–50; 607/101–105; 604/22
See application file for complete search history.

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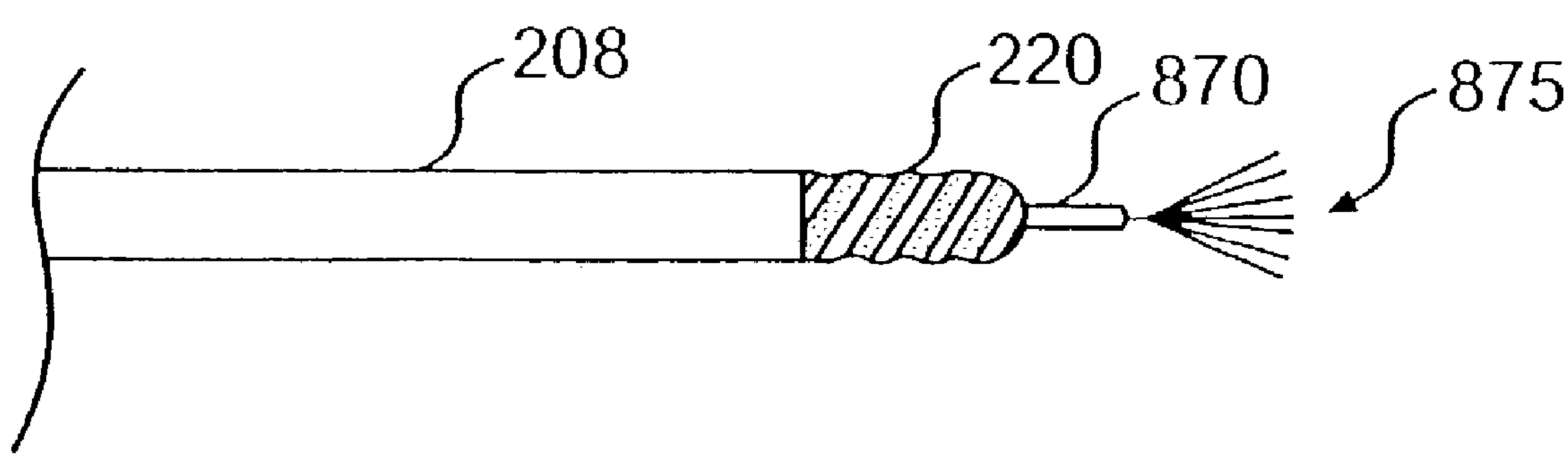
Primary Examiner—Michael Peffley
(74) *Attorney, Agent, or Firm*—Kenyon & Kenyon

(57) **ABSTRACT**

A multi-function surgical instrument is disclosed. In accordance with an embodiment of the present invention, the surgical instrument includes a catheter, a bipolar hemostat assembly, an attachment member, and a surgical tool. The bipolar hemostat assembly includes an electrical connector at a proximal end, a bipolar electrode assembly at a distal end, and first and second electrical leads extending from the proximal end to the distal end and disposed within the catheter. The bipolar electrode assembly includes an aperture that extends axially therethrough. The attachment member is disposed within the catheter and has a proximal end and a distal end where the distal end is movable within the aperture of the bipolar electrode assembly between a first position wherein the distal end is extended from the bipolar electrode assembly and a second position wherein the distal end is retracted within the bipolar electrode assembly. The surgical tool is attached to the distal end of the attachment member.

3 Claims, 15 Drawing Sheets



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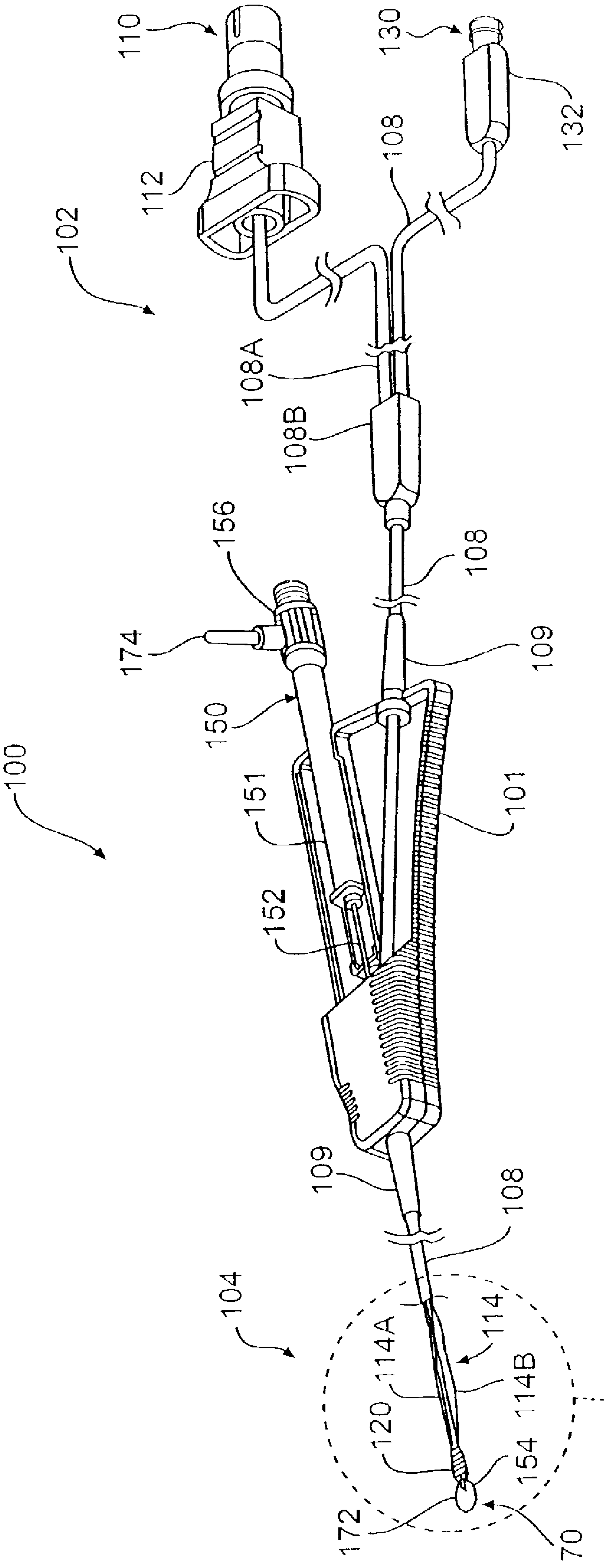
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112
102
130
132
108
108A
108B
156
174
108
109
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100
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101
152
109
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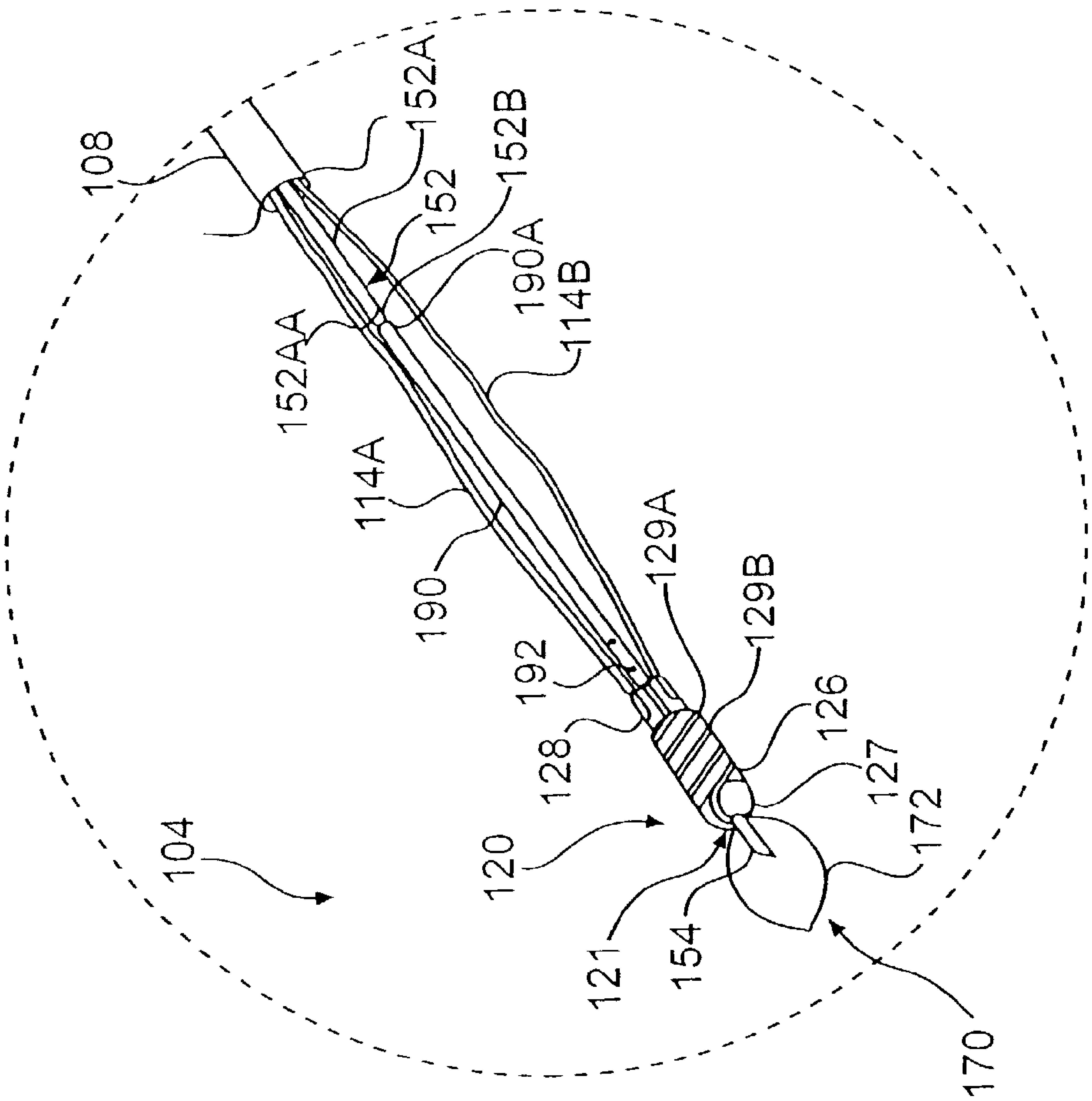
104
114
114A
114B
120
154
172
170
FIG. 2

FIG. 1


108
152A
152B
152
190A
114B
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114A
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126
128
127
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104
120
121
154
170

FIG. 2

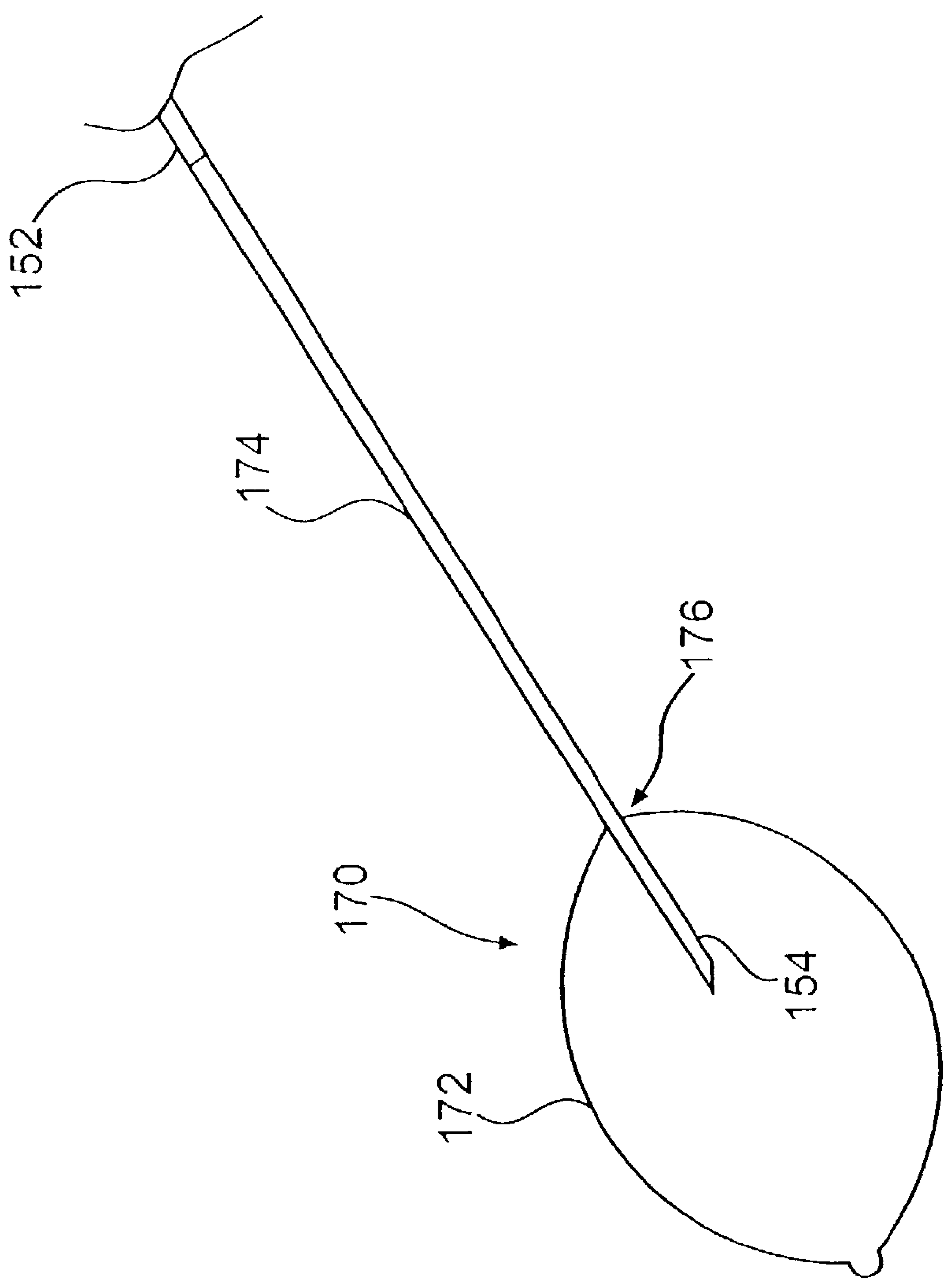
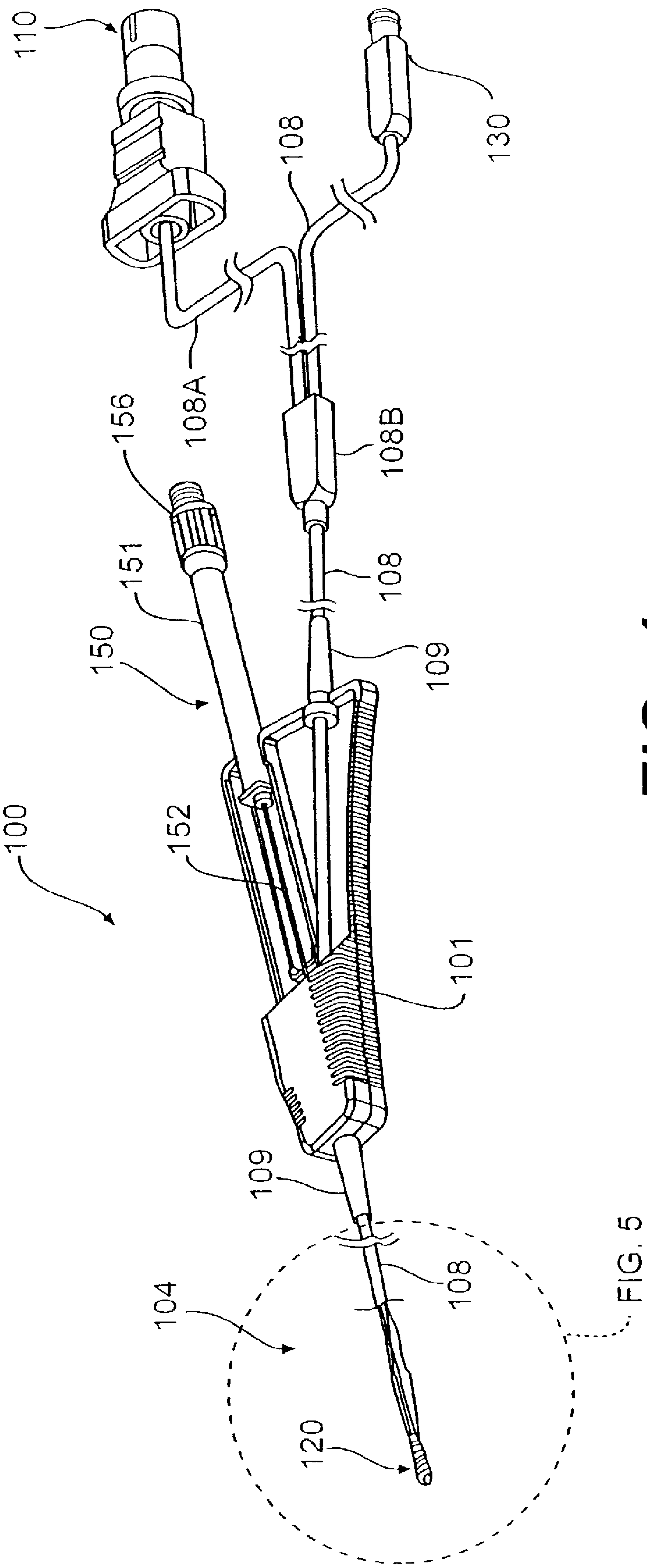


FIG. 3


110
130
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108A
156
108B
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101
109
FIG. 5
104
108
120

FIG. 4

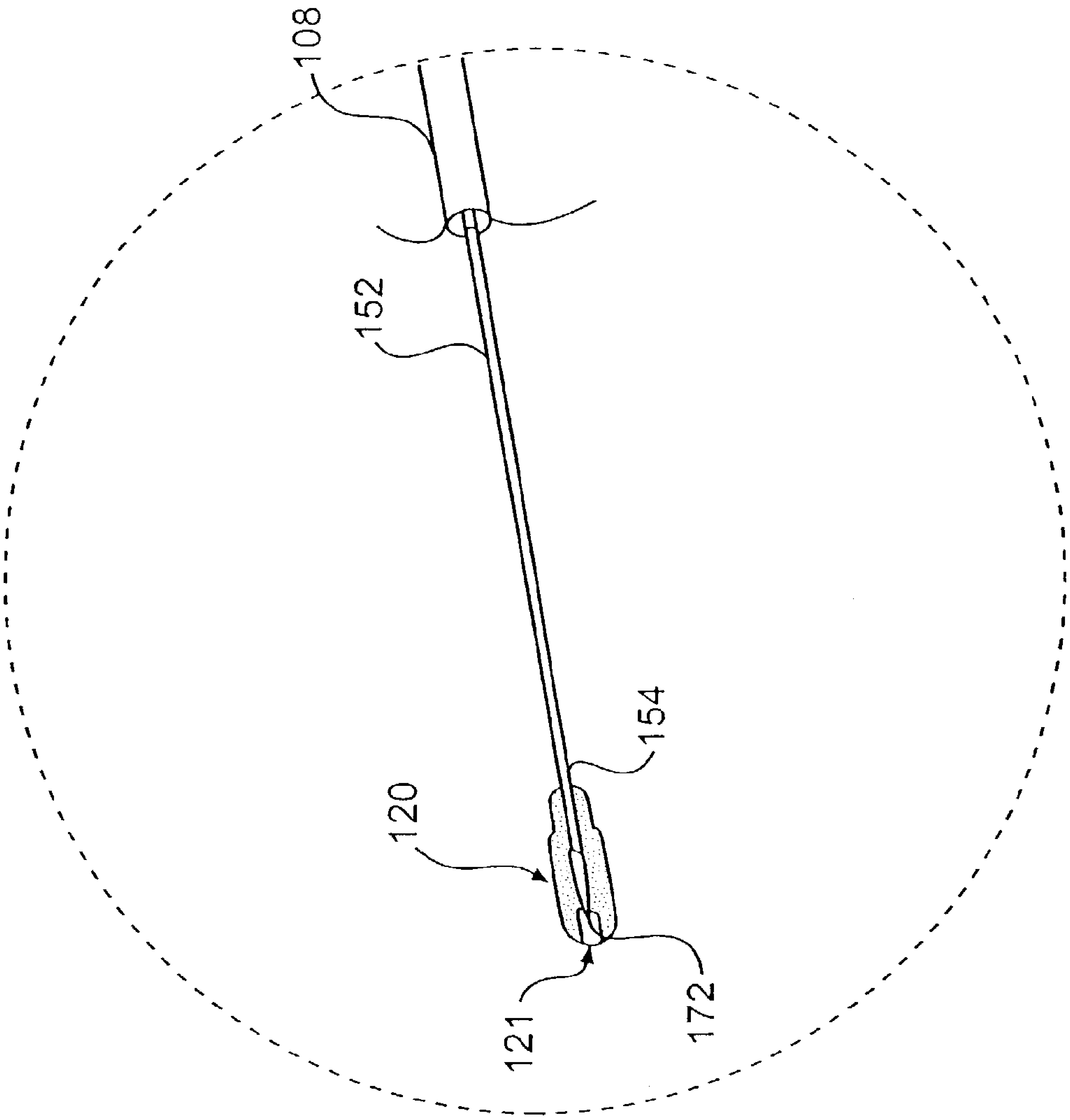


FIG. 5

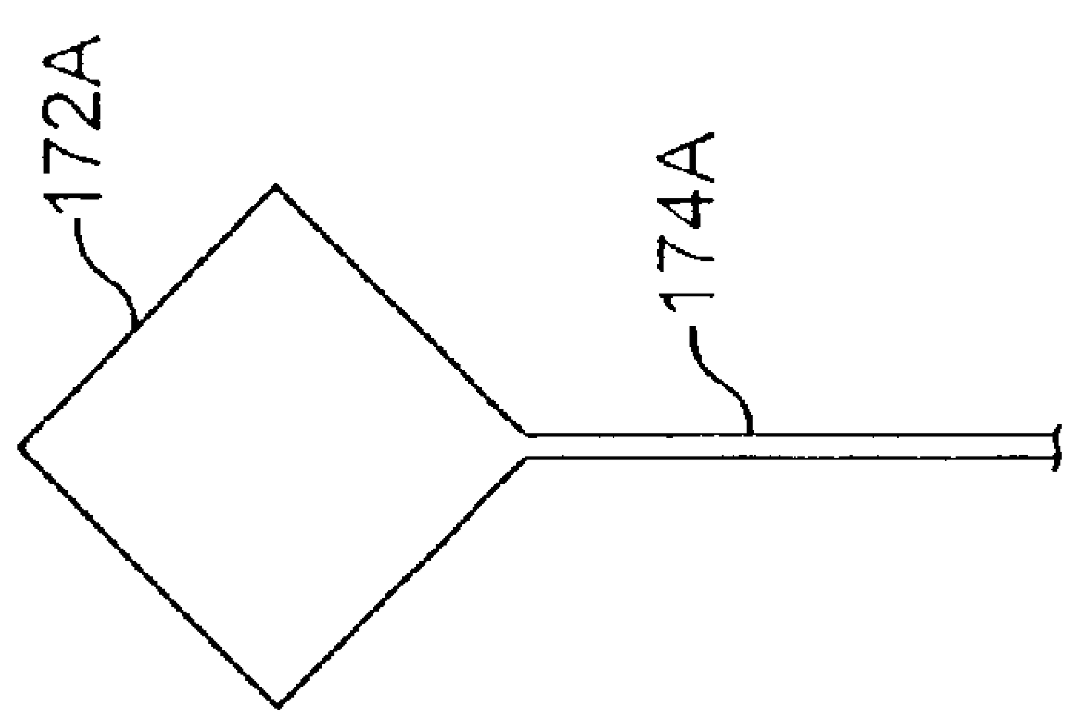
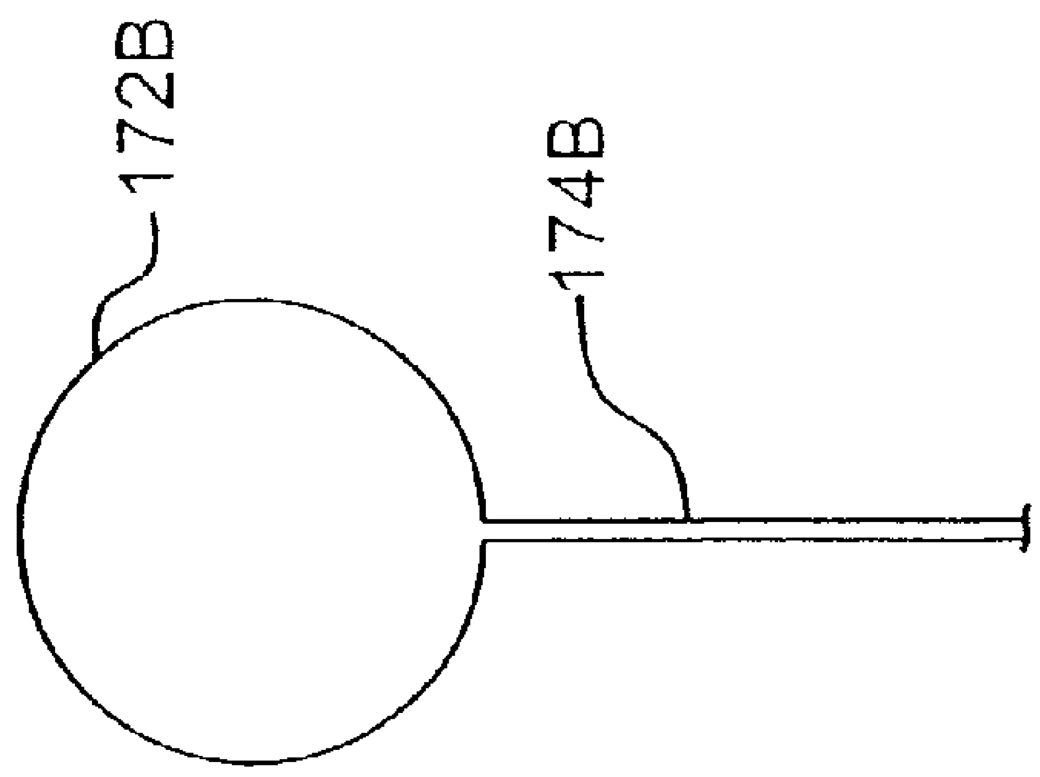


FIG. 6



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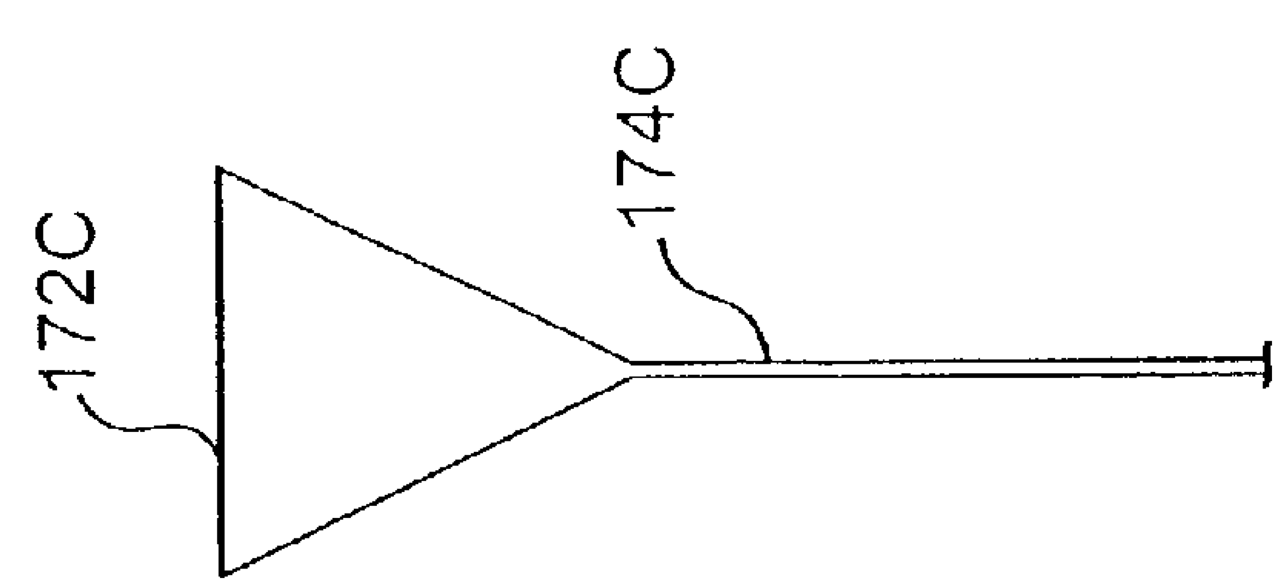

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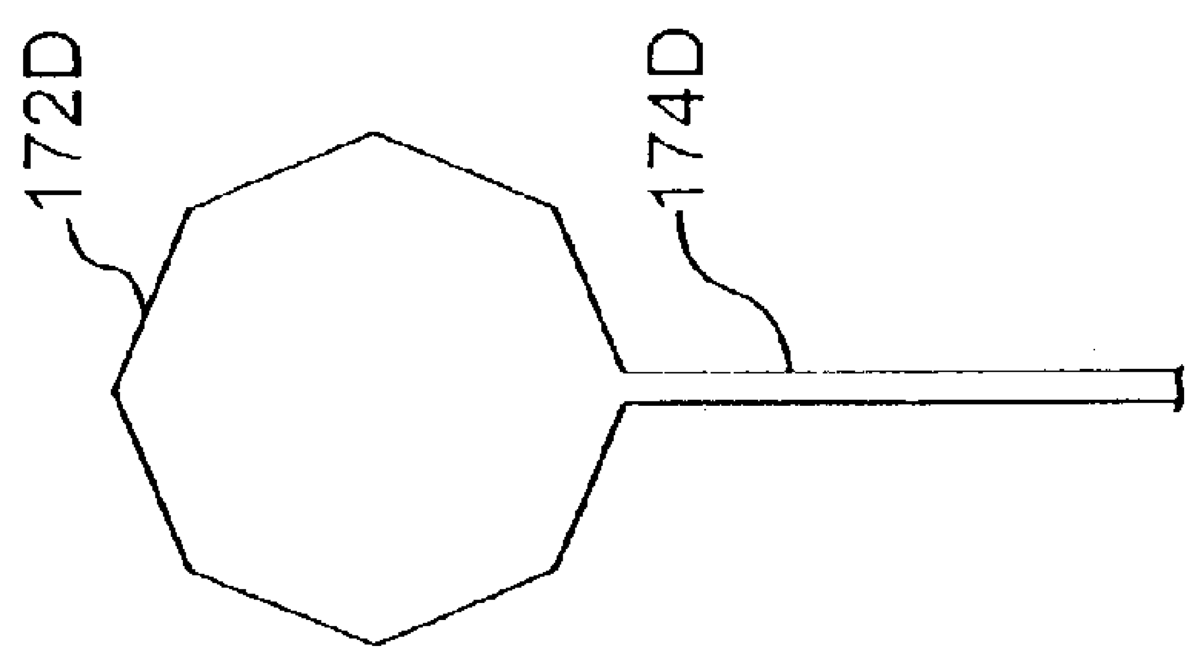

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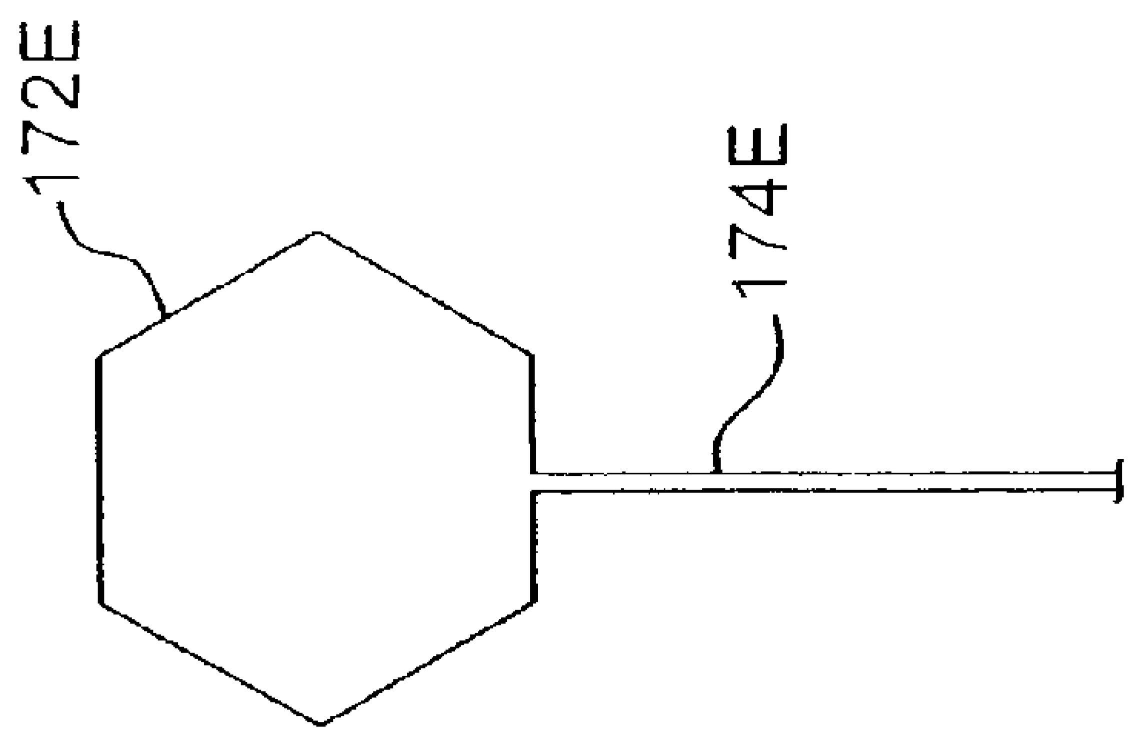

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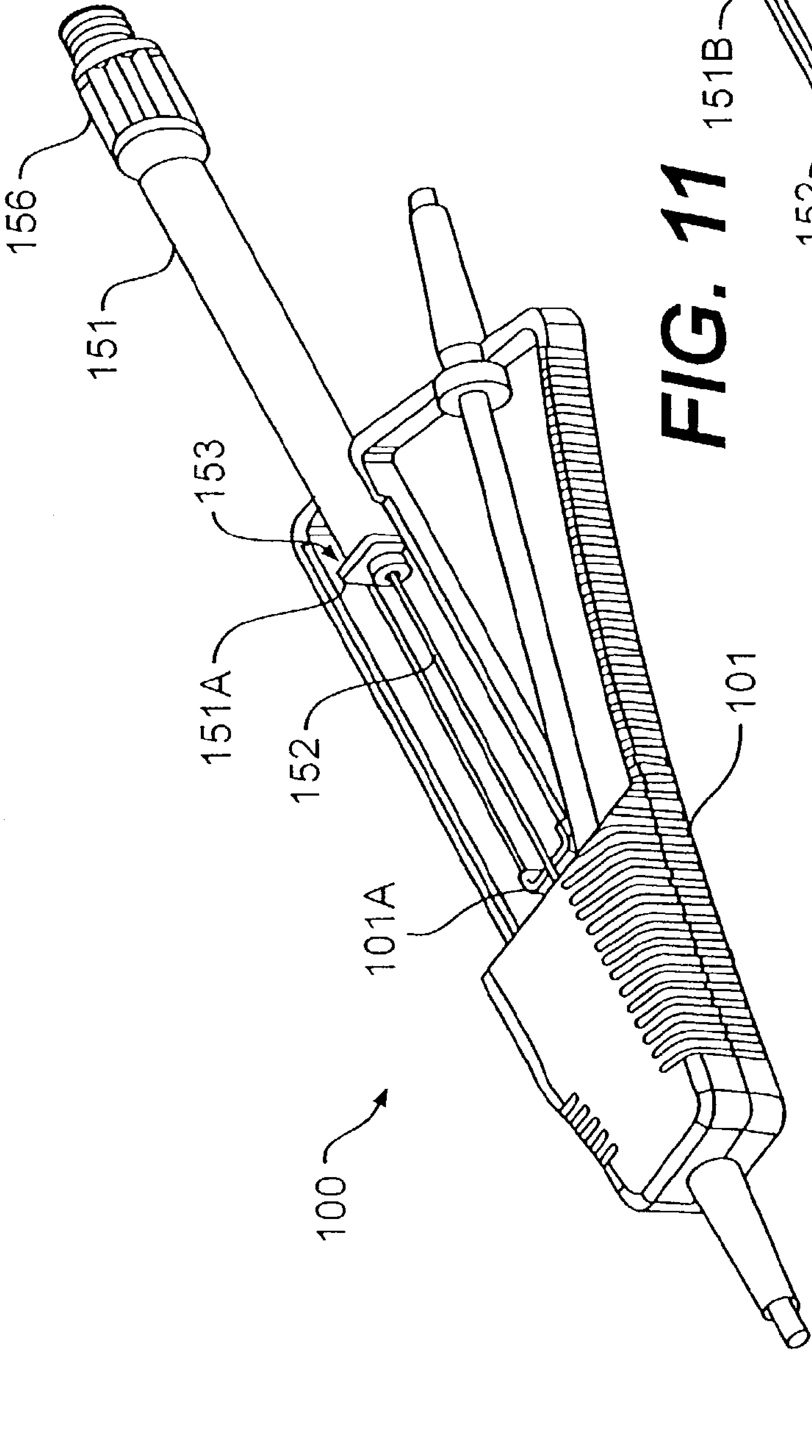

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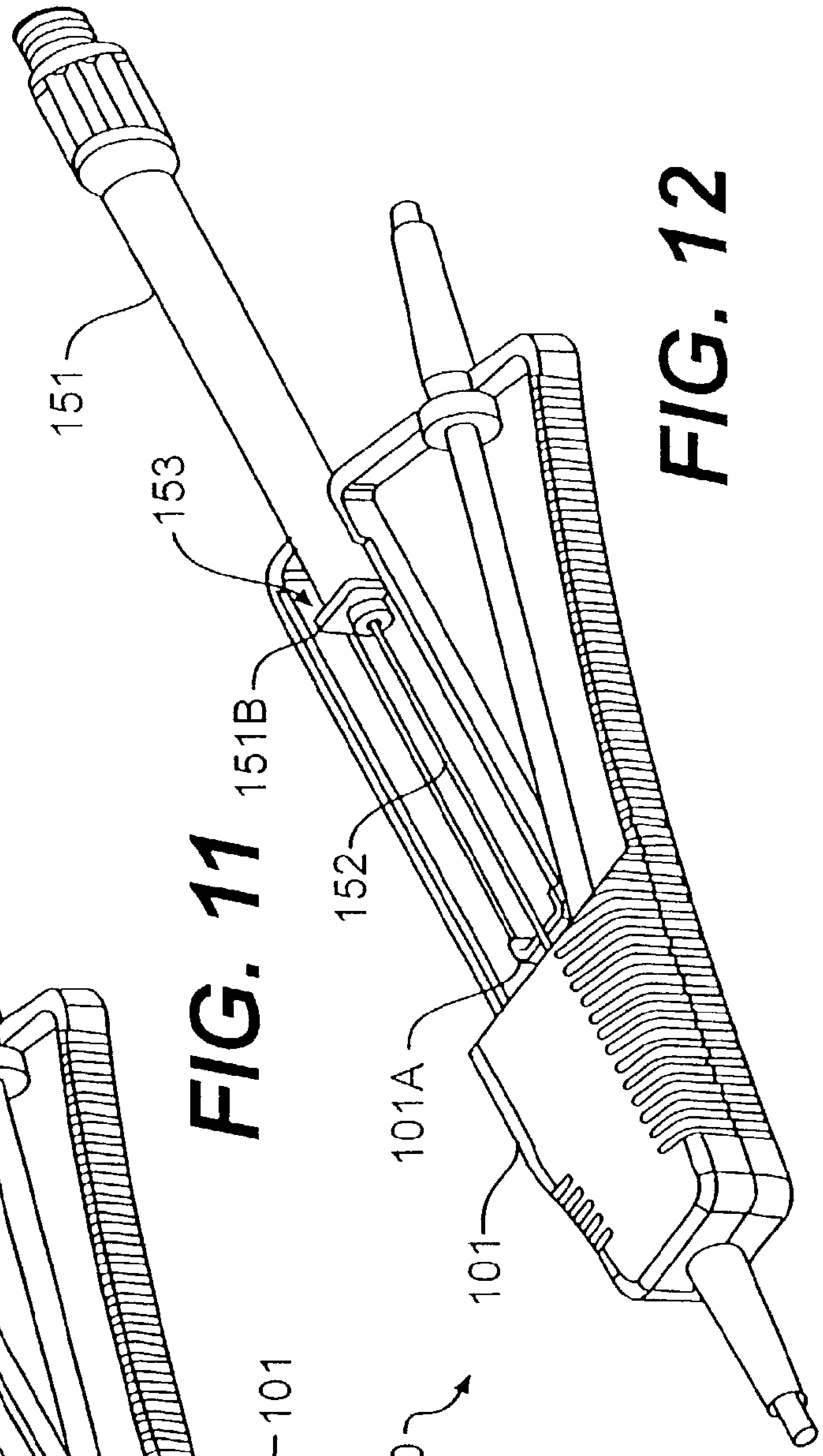

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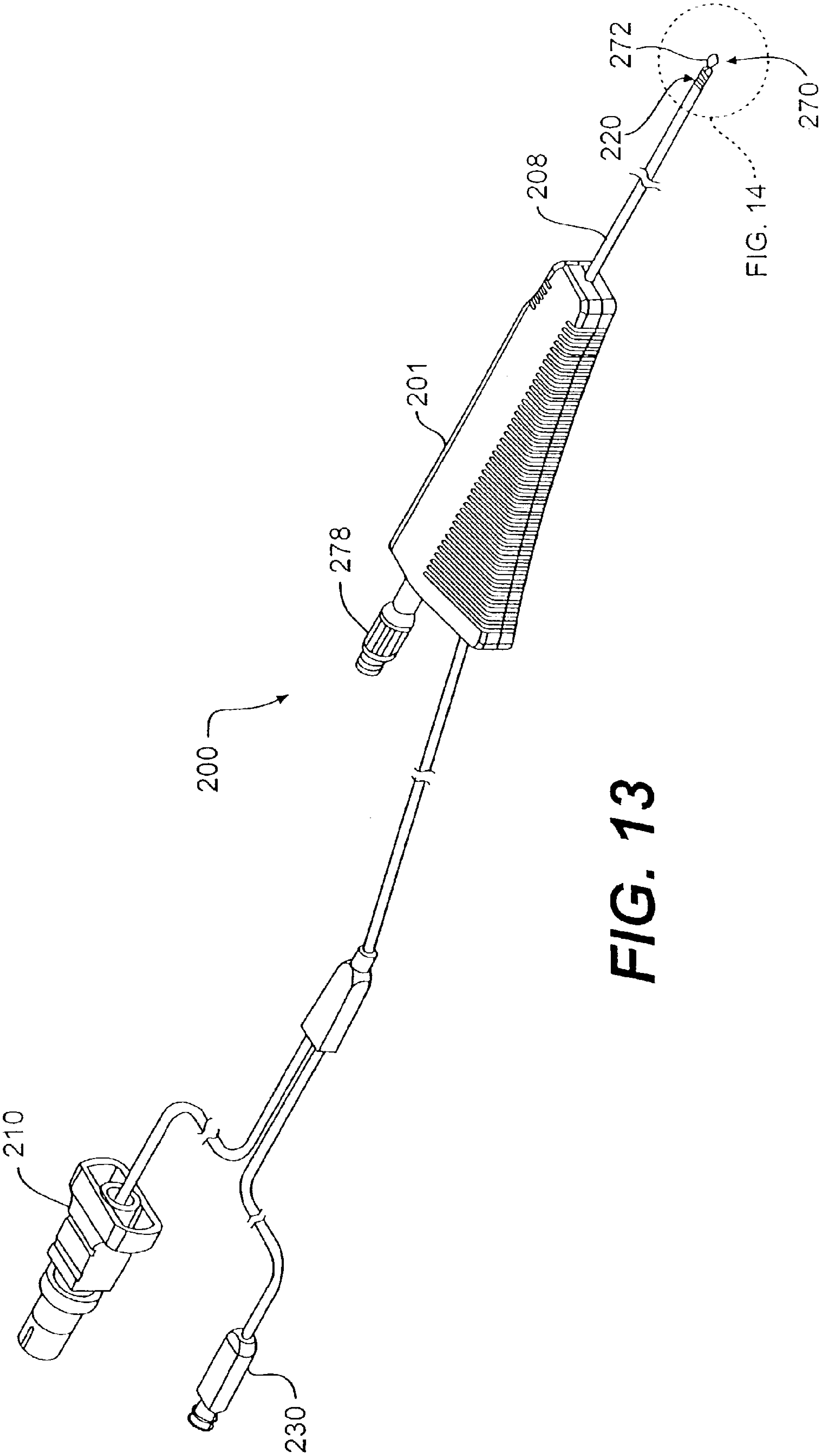
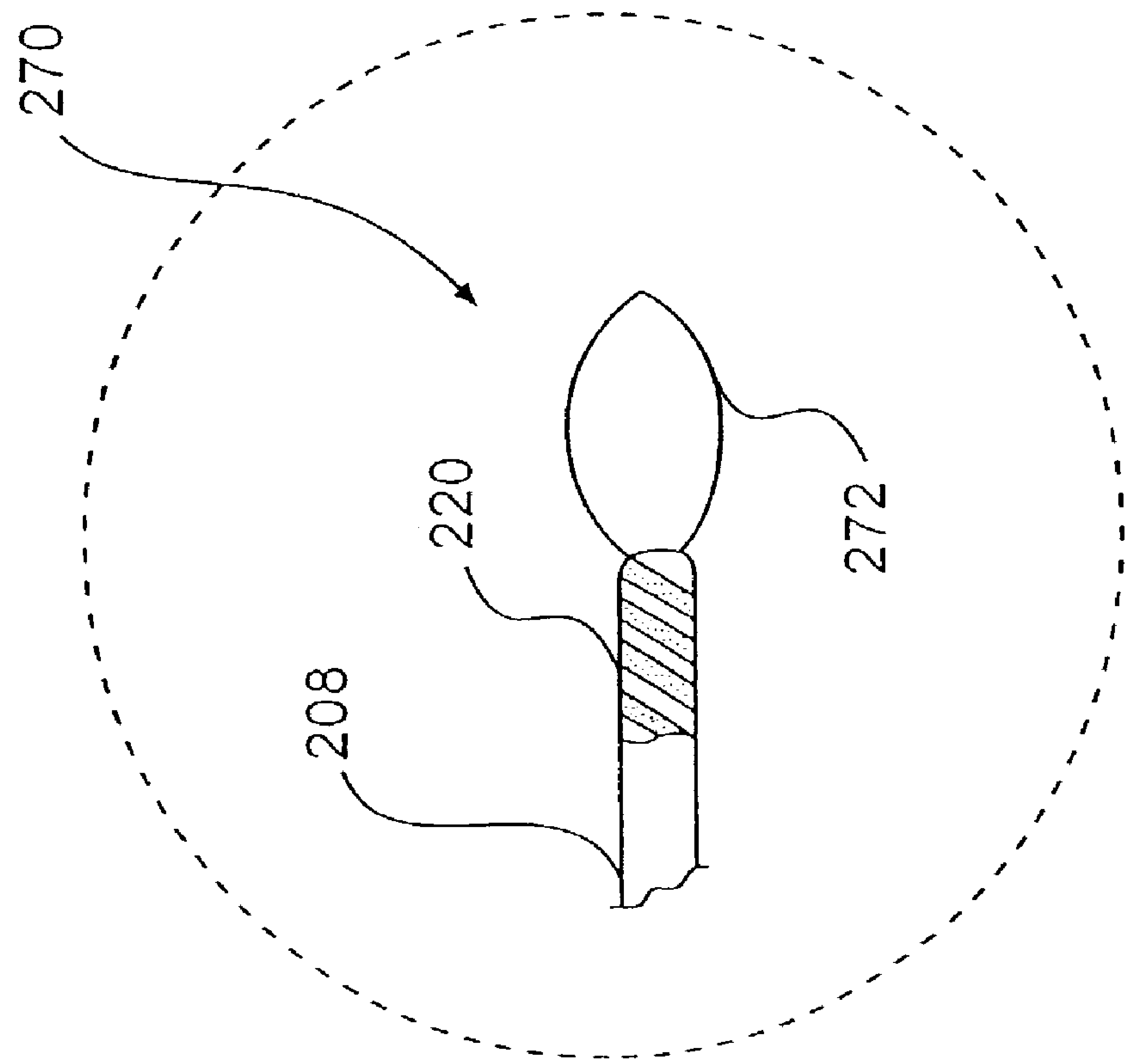


FIG. 13



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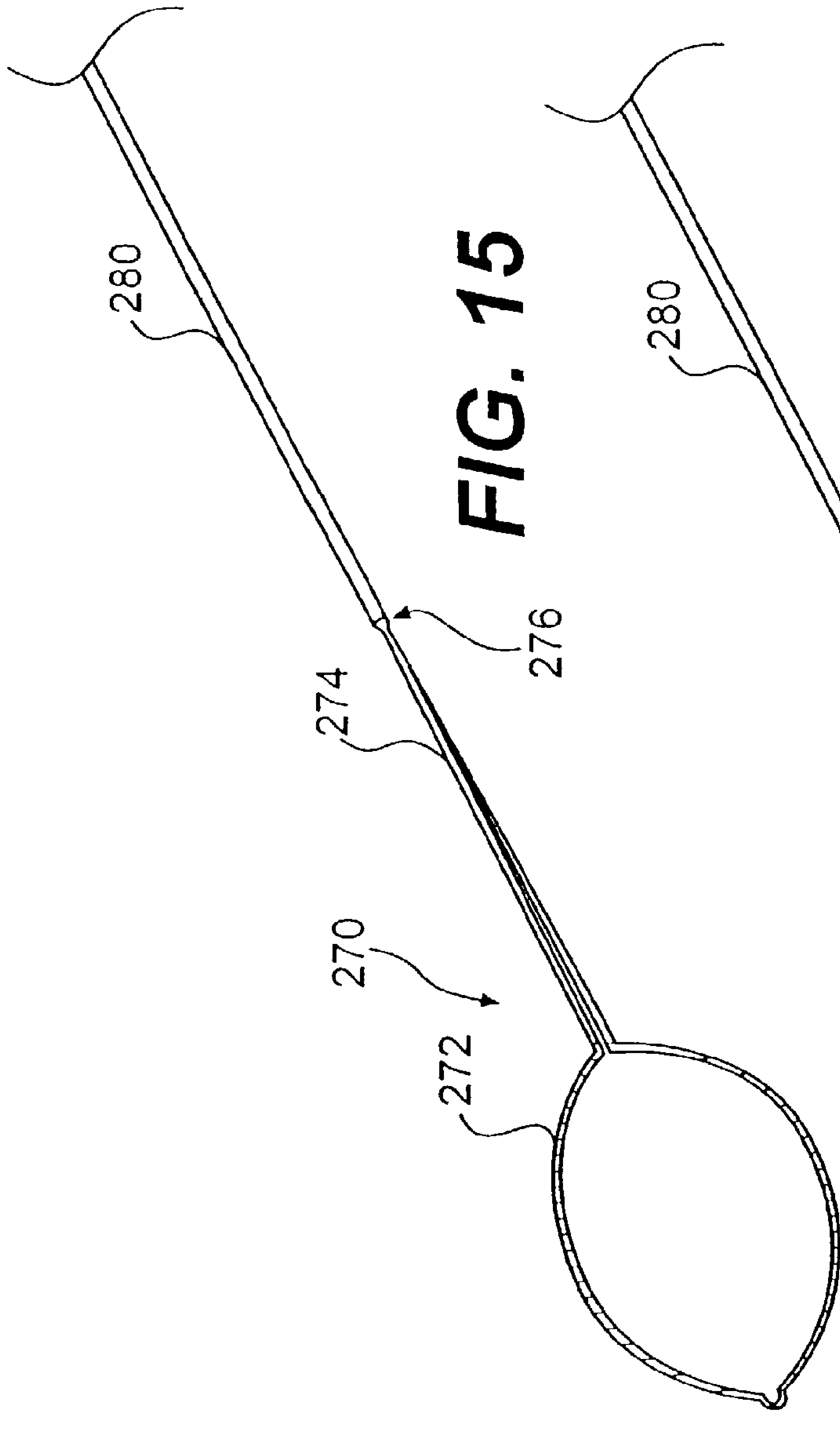

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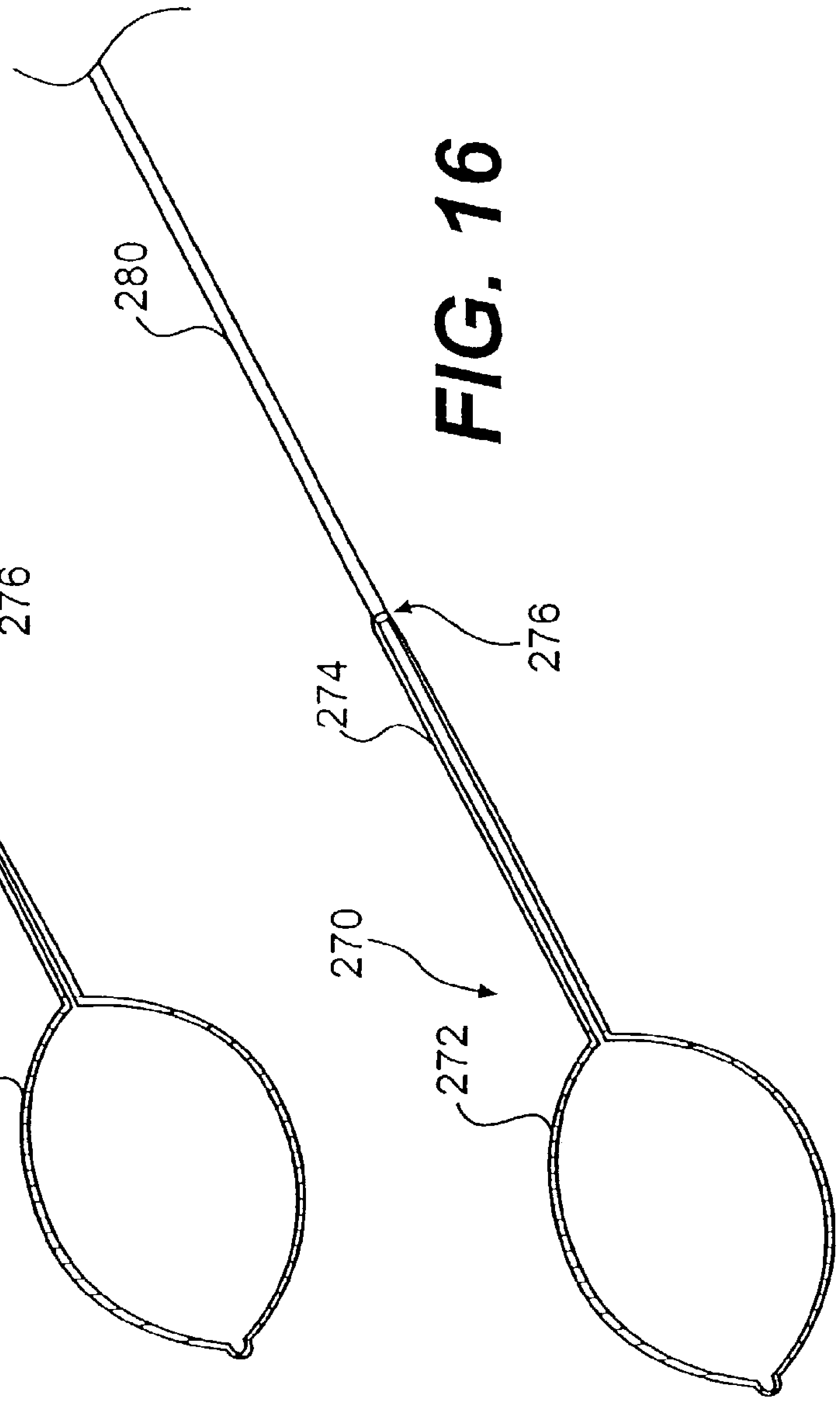

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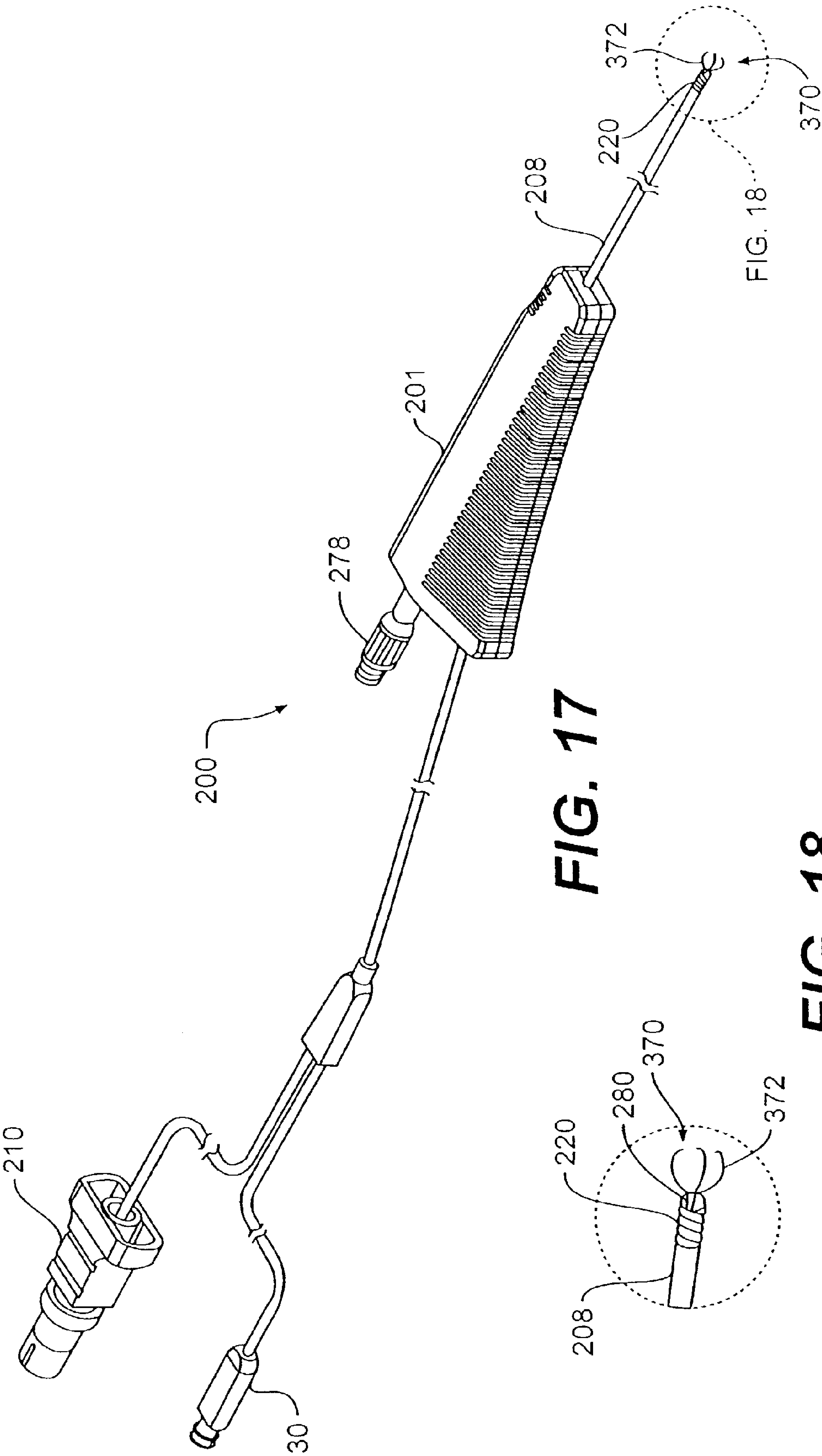
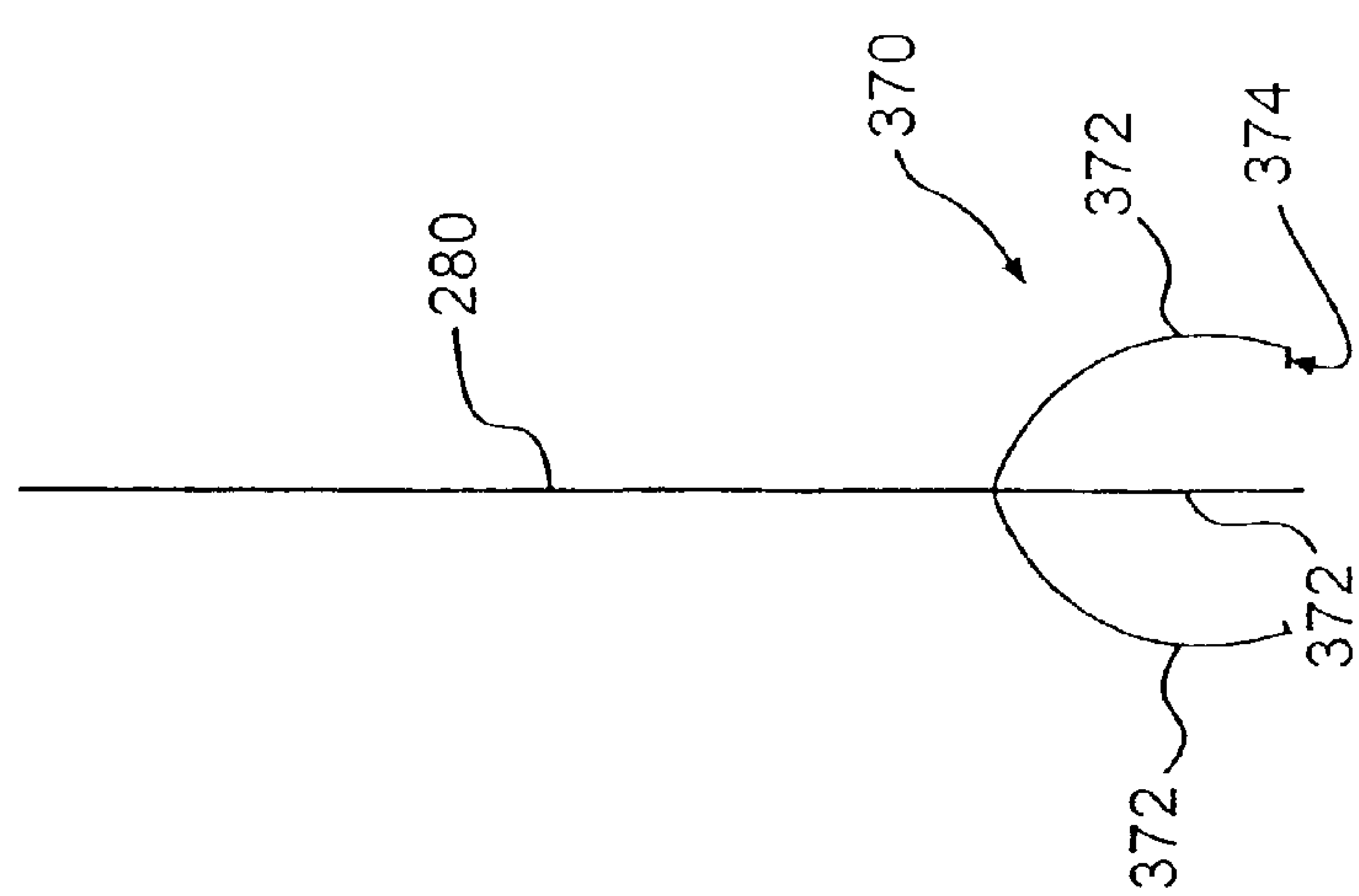


FIG. 17

FIG. 18



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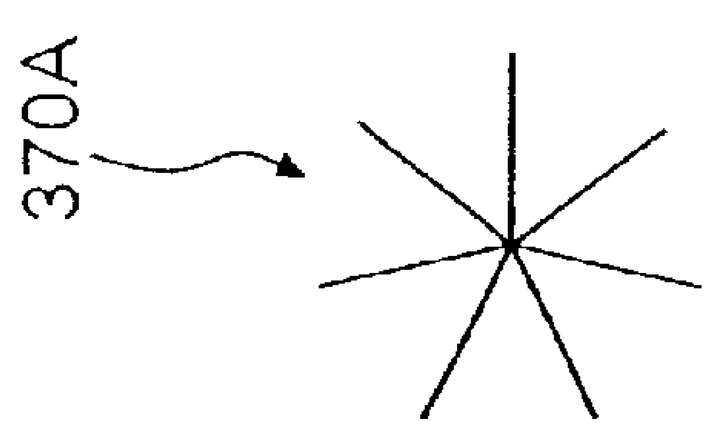

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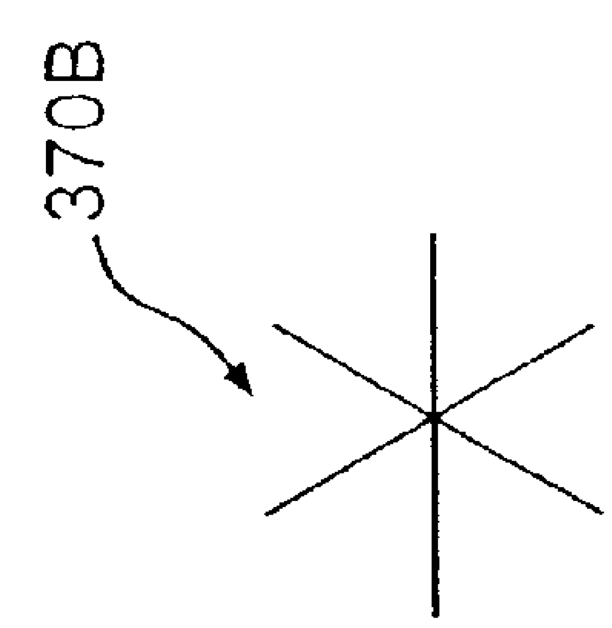

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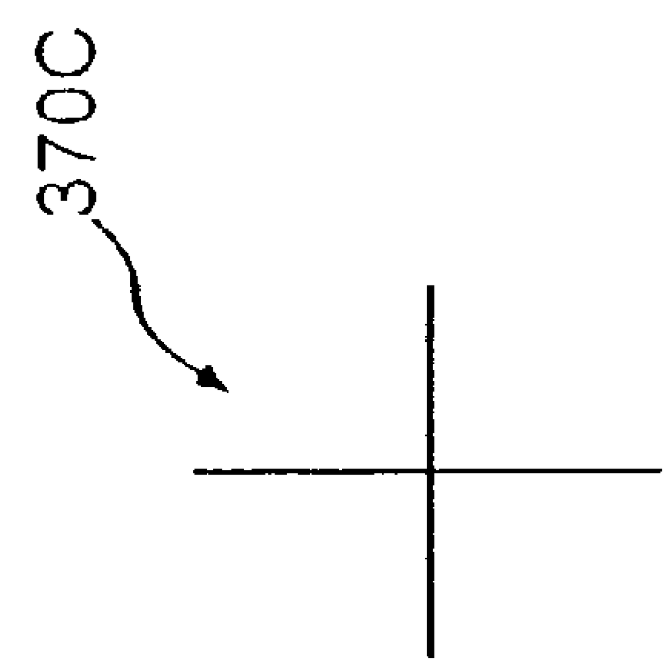

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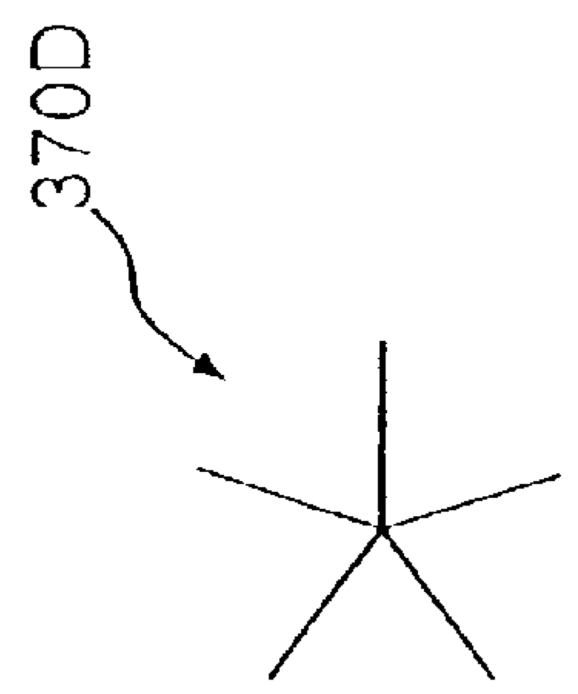


FIG. 23

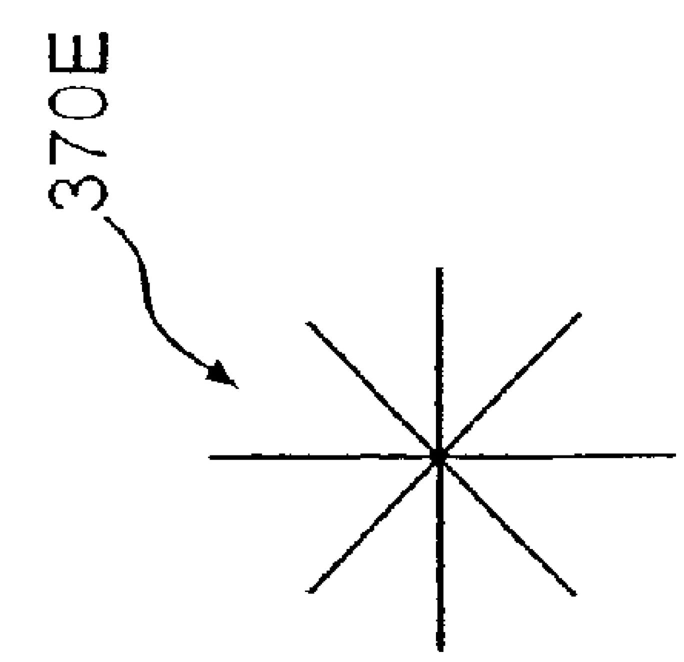


FIG. 24

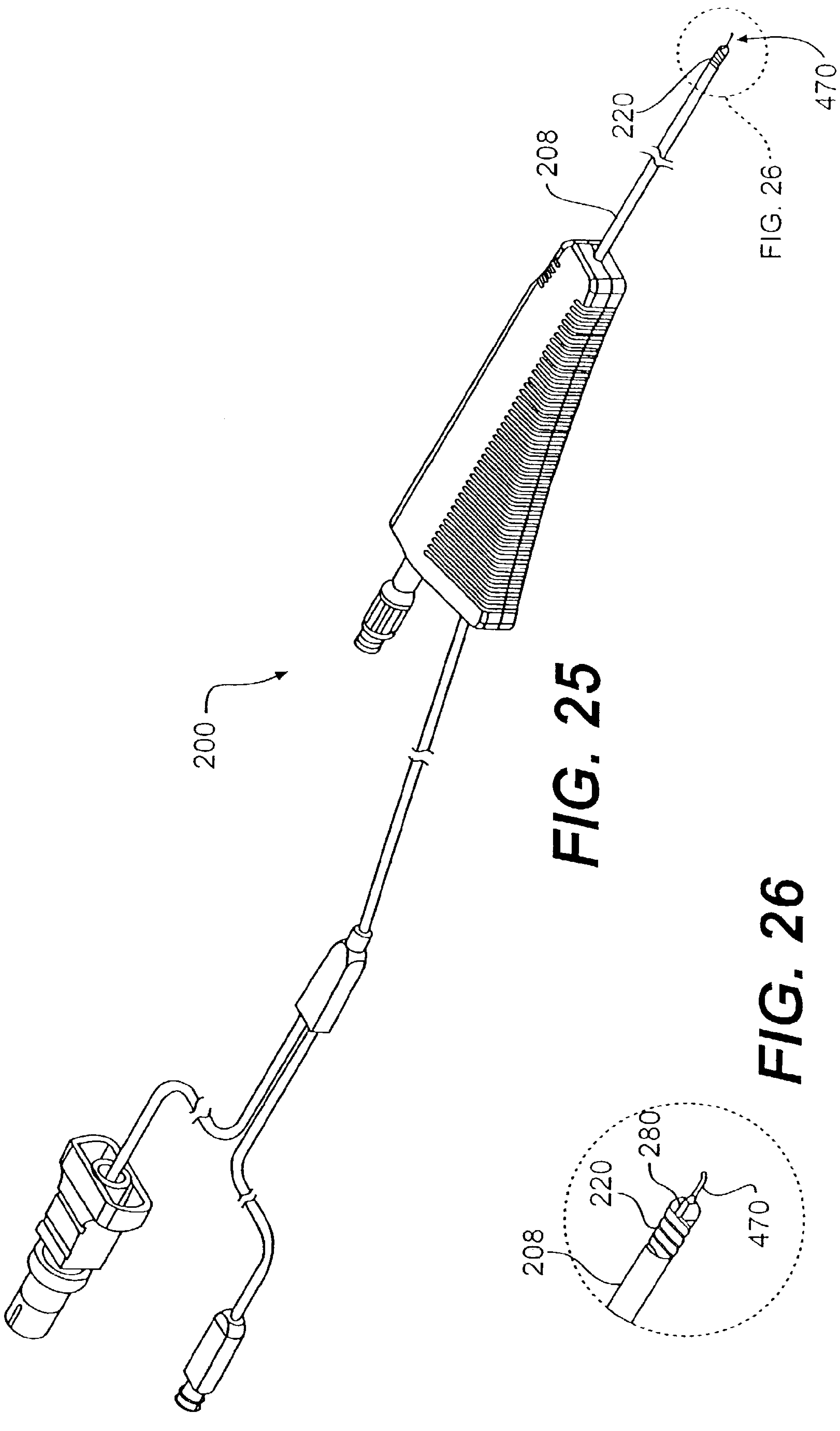


FIG. 25

FIG. 26

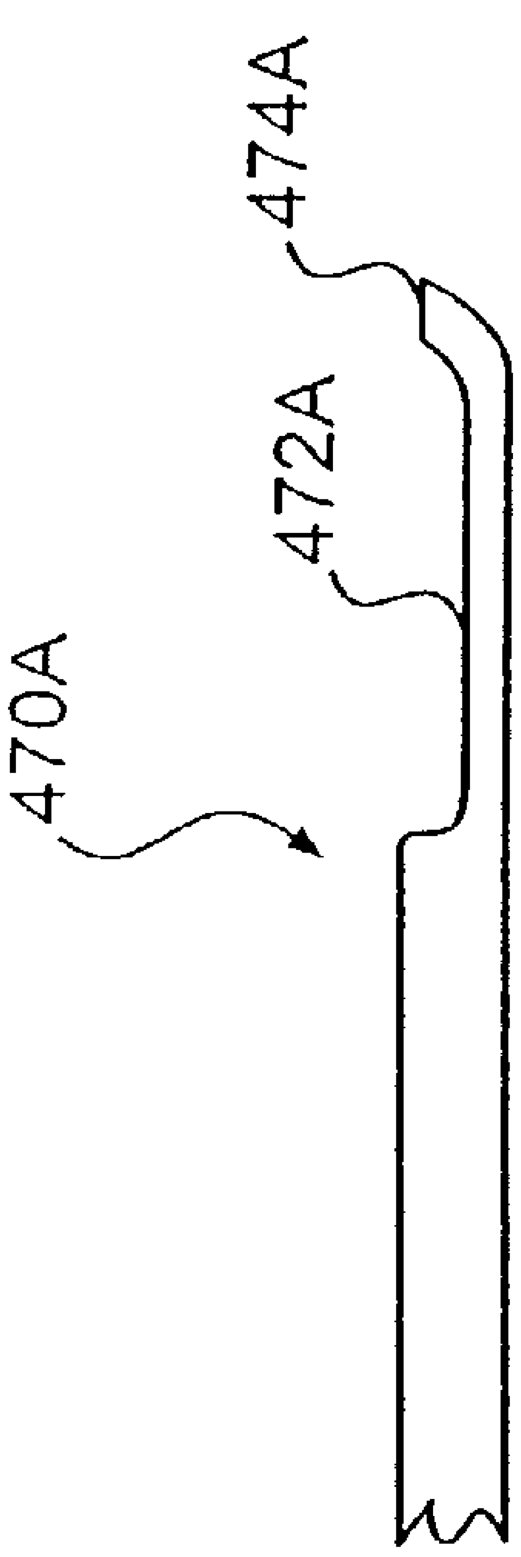


FIG. 27

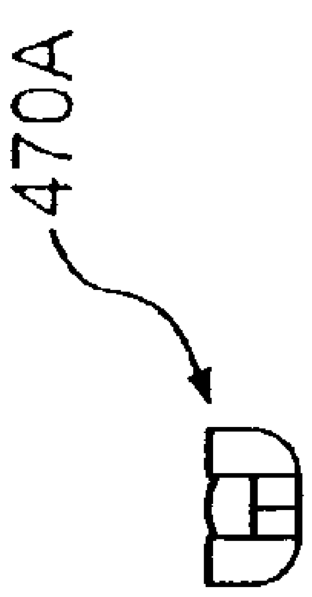


FIG. 28

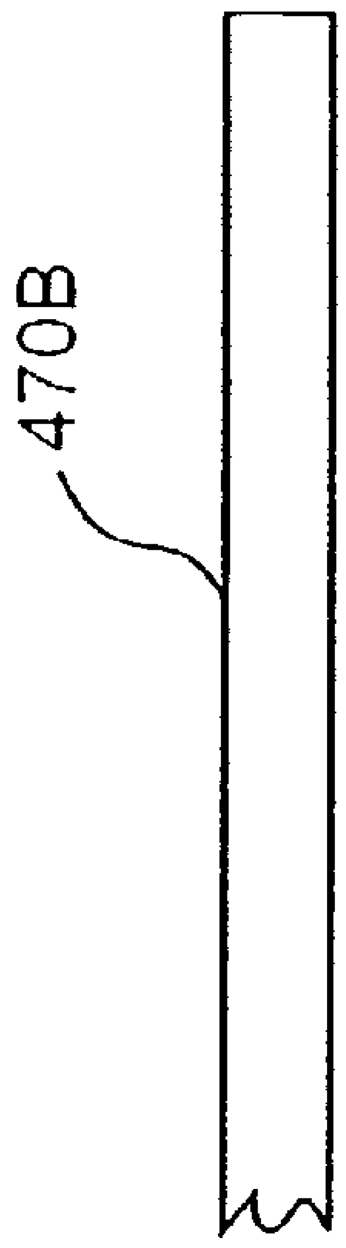


FIG. 29

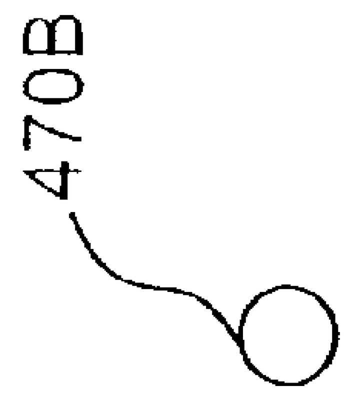


FIG. 30

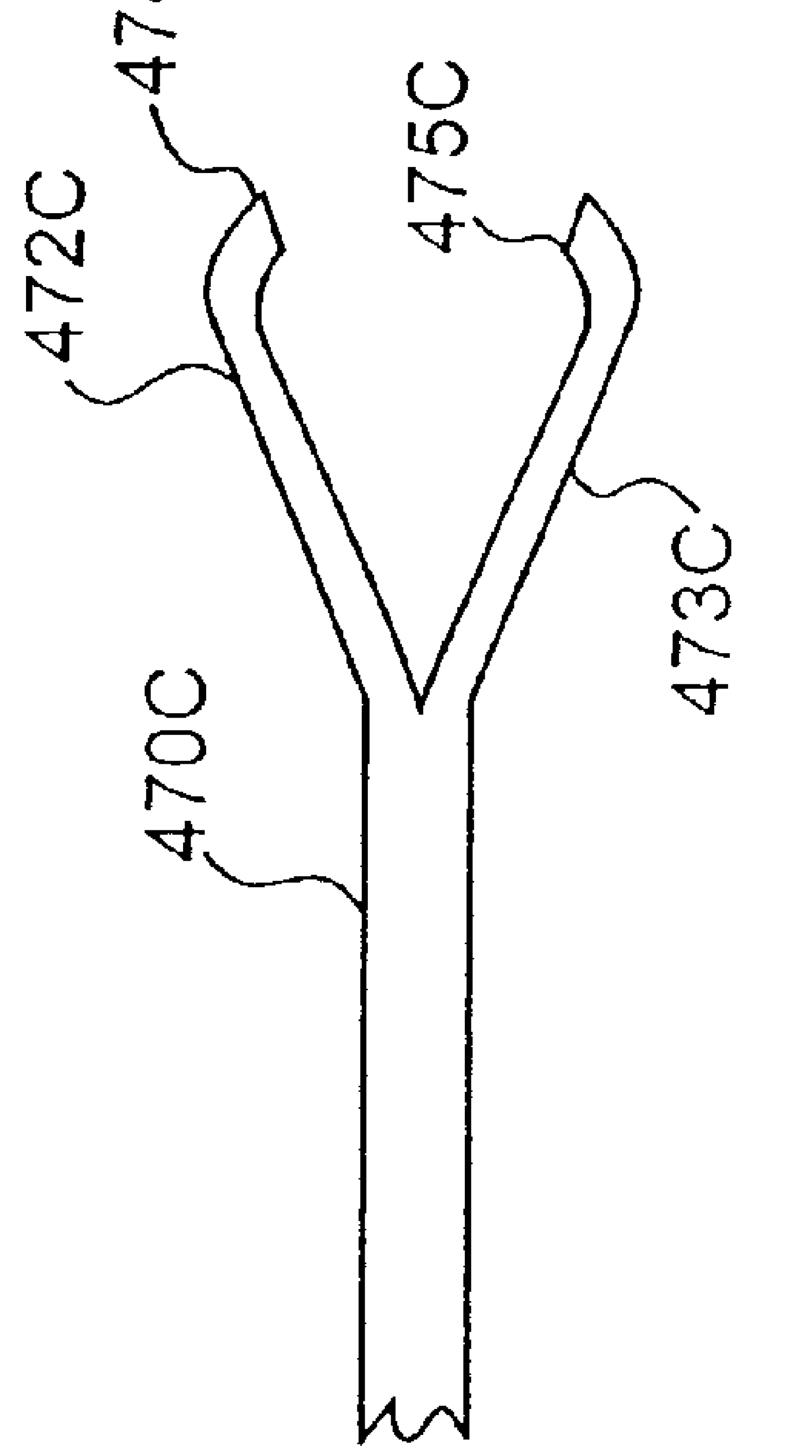
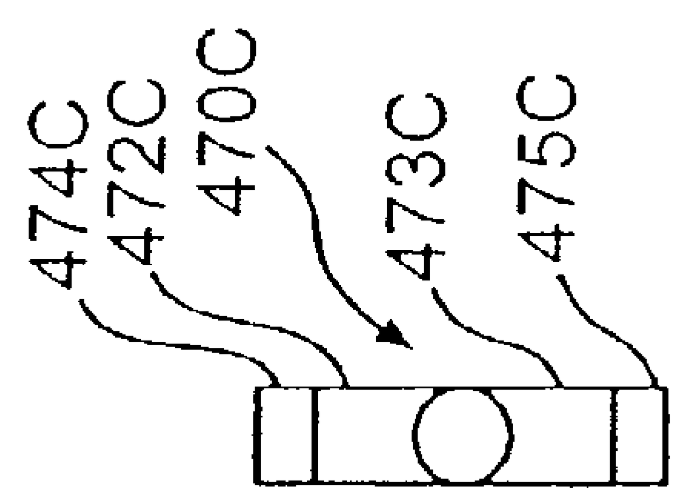


FIG. 31



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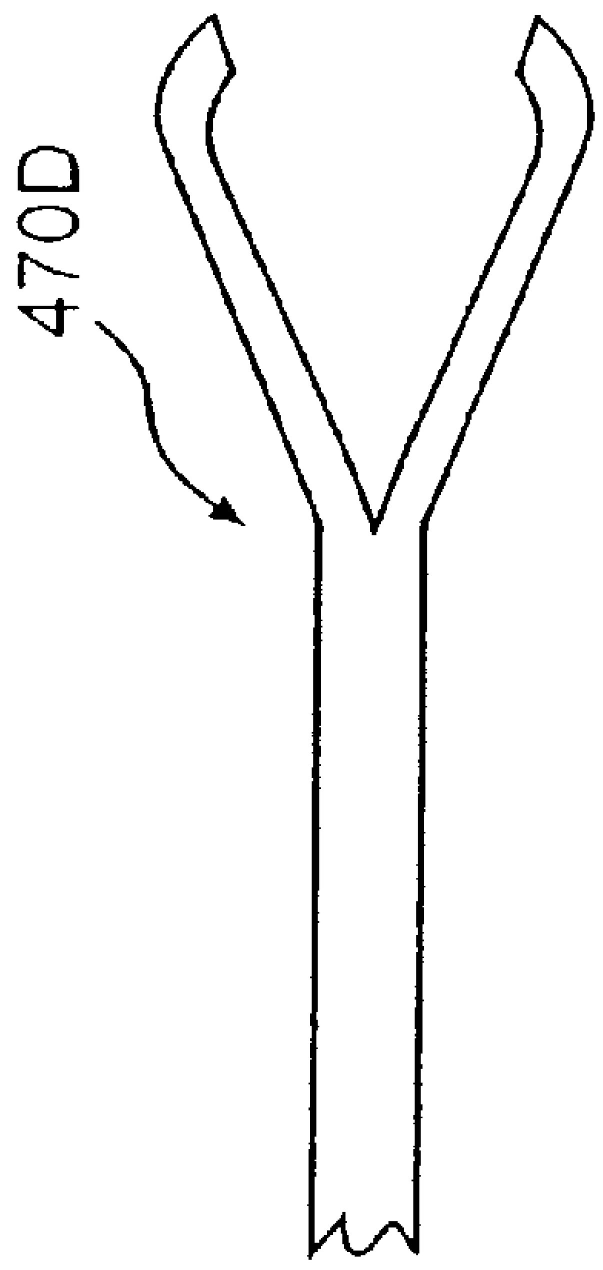


FIG. 33

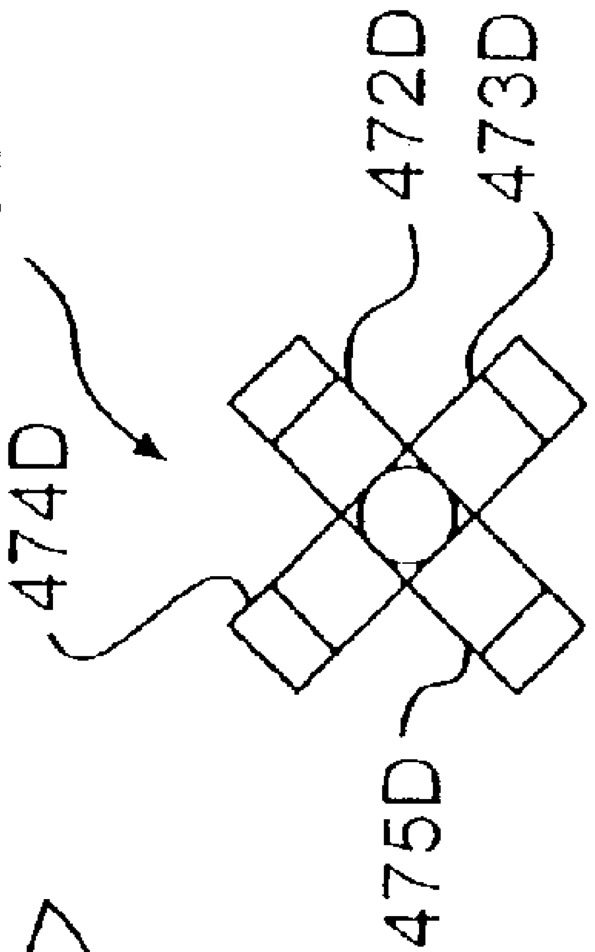


FIG. 34

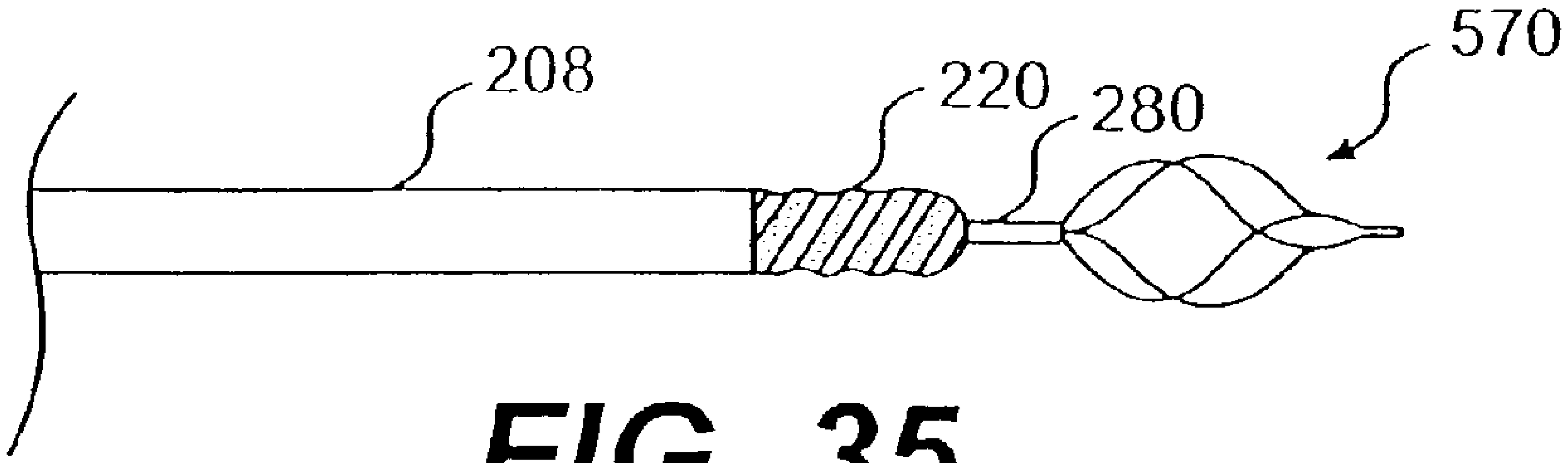


FIG. 35

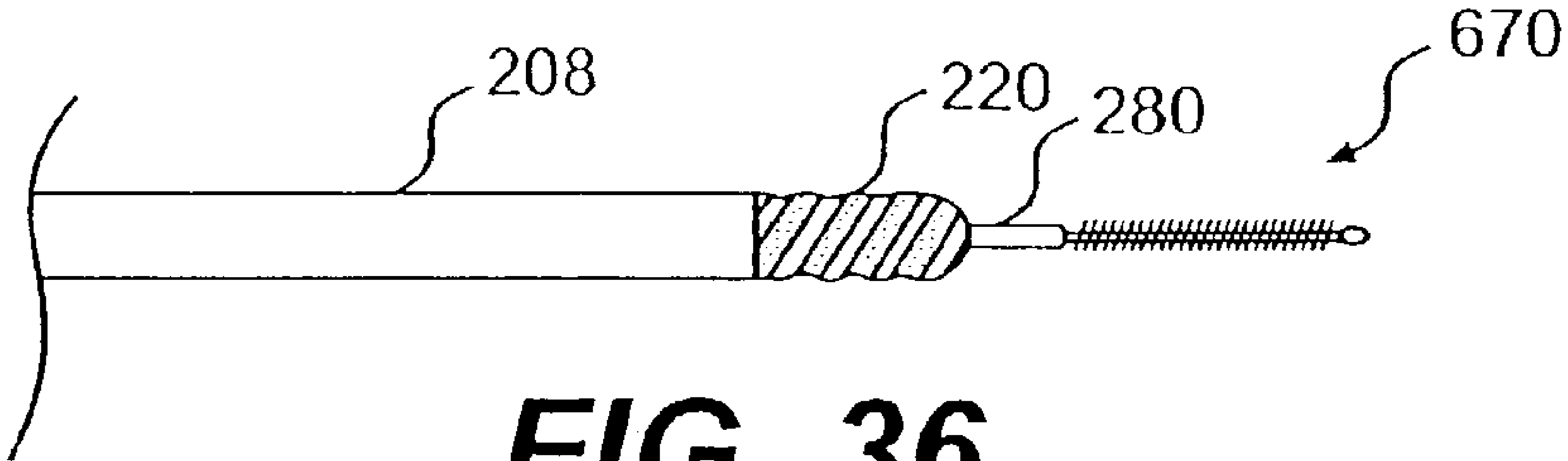
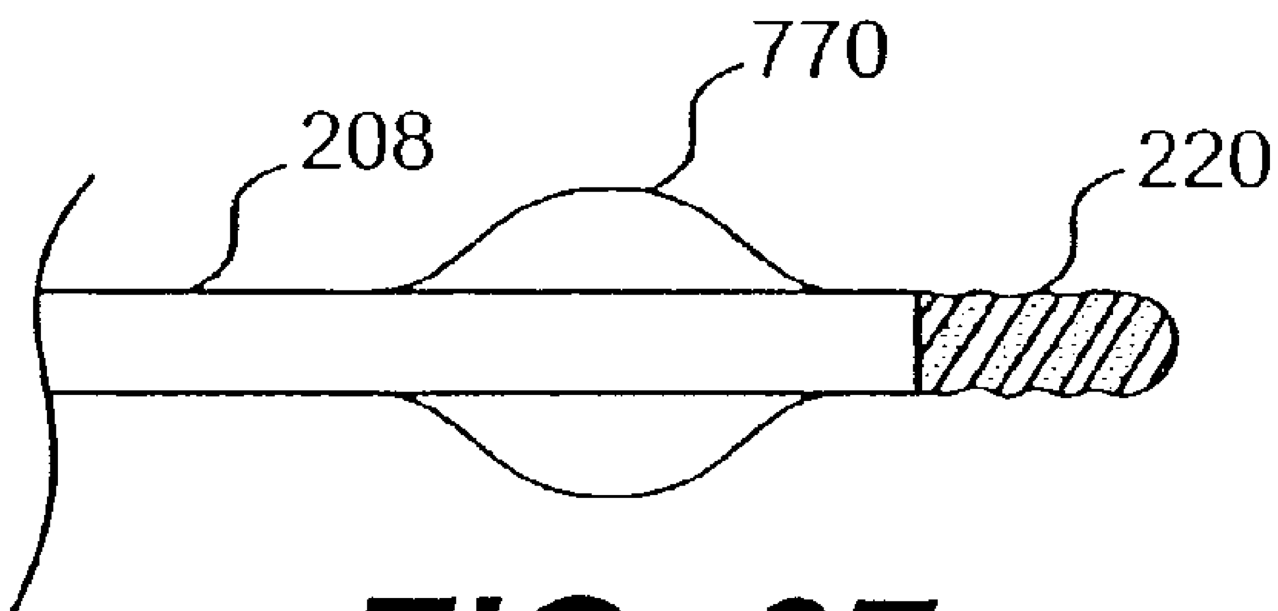


FIG. 36



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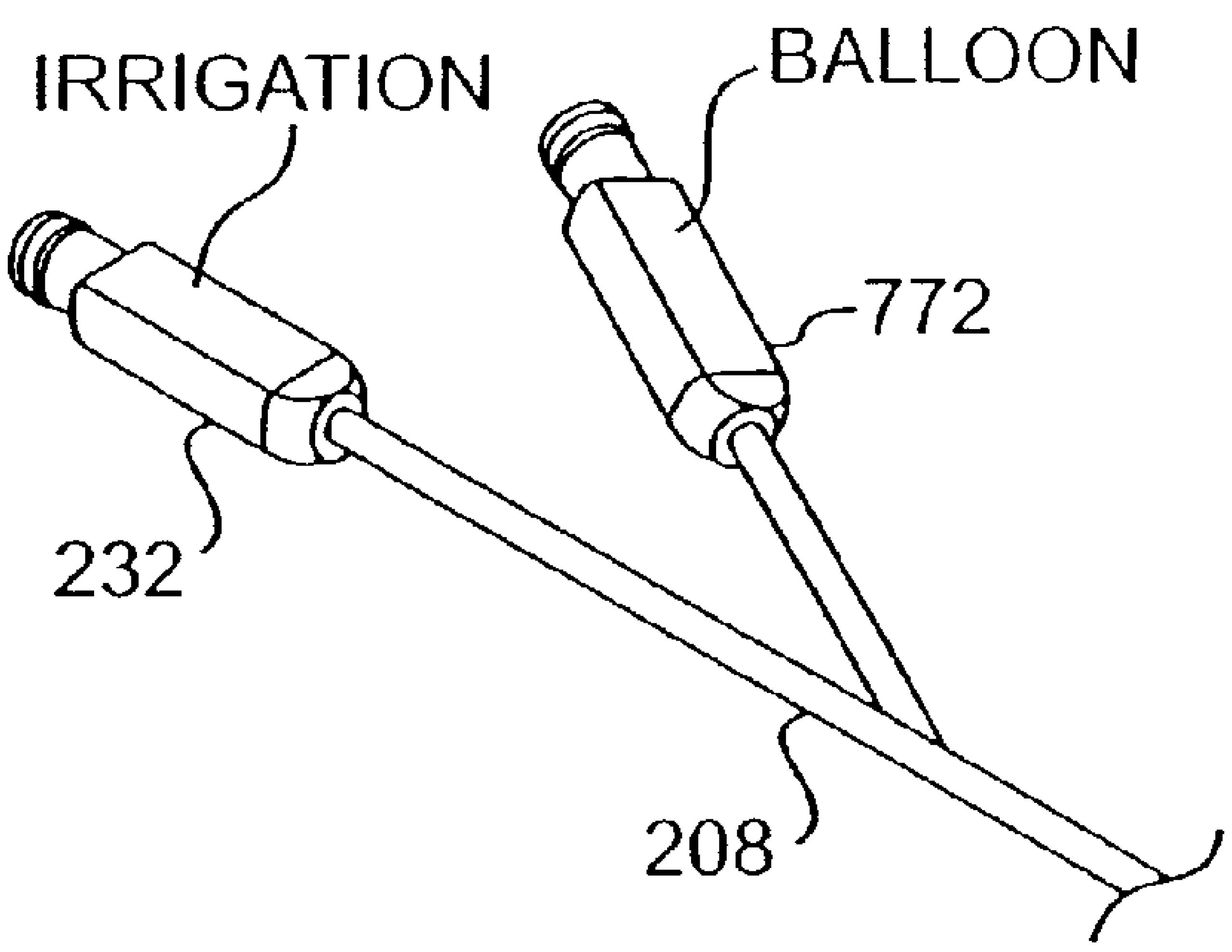

FIG. 38

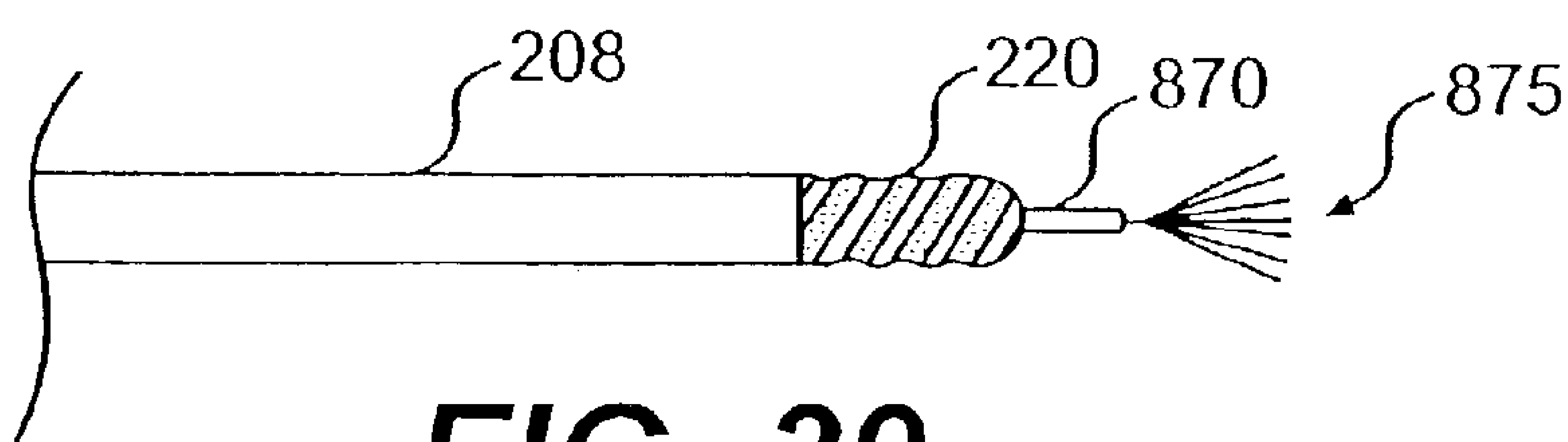

FIG. 39

MULTI-FUNCTION SURGICAL INSTRUMENT

This application is a Continuation of application Ser. No. 09/784,118, filed Feb. 22, 2001, now U.S. Pat. No. 6.610, 056, which is a Divisional of application Ser. No. 09/178, 570, filed Oct. 26, 1998, now U.S. Pat. No. 6,221,039.

BACKGROUND OF THE INVENTION

The present invention relates to a multi-function surgical instrument. More specifically, the invention is a surgical instrument that combines a hemostat assembly with other surgical tools to provide the capability to a surgeon to accomplish multiple surgical procedures with a single instrument.

Currently, a surgical instrument is known that combines a hemostatic capability with an irrigation capability and an injection capability. The instrument provides multifunctionality in a single surgical instrument, which results in efficiencies for the surgeon who is performing a surgical procedure. With the known multi-function surgical instrument, the surgeon is not required to insert and remove multiple surgical instruments from the patient in order to perform the procedure. However, there are procedures that the surgeon may be required to perform that require capabilities in addition to, or different from, those capabilities provided by the multi-function instrument described above. For example, the surgeon may be required to capture a polyp by utilizing a snare device. In this circumstance where the physician is required to perform a procedure that requires a capability that is not included in the multifunction surgical instrument described above, the physician would have to utilize a separate tool in order to obtain this capability. This reduces the efficiency of the surgeon when performing the entire procedure.

Therefore, it would be desirable to provide a multi-function surgical instrument that could provide other capabilities to the surgeon, in combination with a hemostatic capability, in a single surgical instrument.

SUMMARY OF THE INVENTION

In accordance with an embodiment of the present invention, a multi-function surgical instrument is provided. The surgical instrument includes a catheter, a bipolar hemostat assembly, an attachment member, and a surgical tool. The bipolar hemostat assembly includes an electrical connector at a proximal end, a bipolar electrode assembly at a distal end, and first and second electrical leads extending from the proximal end to the distal end and disposed within the catheter. The bipolar electrode assembly includes an aperture that extends axially therethrough. The attachment member is disposed within the catheter and has a proximal end and a distal end where the distal end is movable within the aperture of the bipolar electrode assembly between a first position wherein the distal end is extended from the bipolar electrode assembly and a second position wherein the distal end is retracted within the bipolar electrode assembly. The surgical tool is attached to the distal end of the attachment member.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** illustrates a first embodiment for a multi-function surgical instrument in accordance with the present invention.

FIG. **2** is a view of the distal end of the surgical instrument of FIG. **1**.

FIG. **3** illustrates an embodiment for the configuration of the attachment between the snare and injection needle.

FIG. **4** illustrates the surgical instrument of FIG. **1** in a second position where the snare has been retracted within the bipolar electrode assembly.

FIG. **5** is a view of a distal end of a surgical instrument in the second position where the snare has been retracted within the bipolar electrode assembly.

FIG. **6** illustrates a second embodiment for the geometric configuration for a snare loop of the present invention.

FIG. **7** illustrates a third embodiment for the geometric configuration for a snare loop of the present invention.

FIG. **8** illustrates a fourth embodiment for the geometric configuration for a snare loop of the present invention.

FIG. **9** illustrates a fifth embodiment for the geometric configuration for a snare loop of the present invention.

FIG. **10** illustrates a sixth embodiment for the geometric configuration for a snare loop of the present invention.

FIG. **11** illustrates an alternative embodiment for the multi-function surgical instrument of the present invention where the needle hub is restrained against rotation.

FIG. **12** illustrates an alternative embodiment for the multi-function surgical instrument of the present invention where the needle hub is rotatable.

FIG. **13** illustrates an alternative embodiment for the multi-function surgical instrument of the present invention where the snare is attached to an attachment member.

FIG. **14** is a view of the distal end of the instrument of FIG. **13**.

FIG. **15** illustrates a first embodiment for the attachment of the snare to the attachment member for the embodiment of the instrument of FIG. **13**.

FIG. **16** illustrates a second embodiment for the attachment of the snare to the attachment member for the embodiment of the instrument of FIG. **13**.

FIG. **17** illustrates an alternative embodiment for the multi-function surgical instrument of the present invention where a grasper/forceps device is attached to a support member.

FIG. **18** is a view of the distal end of the instrument of FIG. **17**.

FIG. **19** illustrates an embodiment of a configuration for a grasper/forceps device of the present invention.

FIG. **20** illustrates a second embodiment for the configuration for the grasper/forceps device of the present invention.

FIG. **21** illustrates a third embodiment for the configuration for the grasper/forceps device of the present invention.

FIG. **22** illustrates a fourth embodiment for the configuration for the grasper/forceps device of the present invention.

FIG. **23** illustrates a fifth embodiment for the configuration for the grasper/forceps device of the present invention.

FIG. **24** illustrates a sixth embodiment for the configuration for a grasper/forceps device of the present invention.

FIG. **25** illustrates an alternative embodiment for the multi-function surgical instrument of the present invention where a scraper/forceps device is attached to a support member.

FIG. **26** is a view of the distal end of the instrument of FIG. **25**.

FIG. **27** illustrates an embodiment of a configuration for a scraper/forceps device of the present invention.

FIG. **28** is a front view of the scraper/forceps device of FIG. **27**.

FIG. **29** illustrates a second embodiment for the configuration for the scraper/forceps device of the present invention.

FIG. **30** is a front view of the scraper/forceps device of FIG. **29**.

FIG. **31** illustrates a third embodiment for the configuration for the scraper/forceps device of the present invention.

FIG. **32** is a front view of the scraper/forceps device of FIG. **31**.

FIG. **33** illustrates a fourth embodiment for the configuration for the scraper/forceps device of the present invention.

FIG. **34** is a front view of the scraper/forceps device of FIG. **33**.

FIG. **35** illustrates an alternative embodiment for the multi-function surgical instrument of the present invention where a retrieval basket is attached to a support member.

FIG. **36** illustrates an alternative embodiment for the multi-function surgical instrument of the present invention where a cytology brush is attached to a support member.

FIG. **37** illustrates an alternative embodiment for the multi-function surgical instrument of the present invention where a balloon has been added to the outside diameter of the catheter.

FIG. **38** illustrates a balloon hub that could be attached to the catheter for use with the surgical instrument of FIG. **37**.

FIG. **39** illustrates an alternative embodiment for the multi-function surgical instrument of the present invention where the shaft comprises a cryotherapy tube.

DETAILED DESCRIPTION

FIG. **1** illustrates a first embodiment for the multi-function surgical instrument **100** in accordance with the present invention. As can be seen in FIG. **1**, surgical instrument **100** includes a bipolar hemostat assembly **110**, an irrigation assembly **130**, and a needle assembly **150**.

Bipolar hemostat assembly **110** includes an RF generator connector **112**, electrical leads **114**, and a bipolar electrode assembly **120**. RF generator connector **112** is located at a proximal end **102** of the multi-function surgical instrument **100** and is utilized to provide connection to an RF generator (not shown) in accordance with well-known principles. Electrical leads **114** extend from RF generator connector **112** through the surgical instrument **100** and terminate at the bipolar electrode assembly **120**, which is located at the distal end **104** of the surgical instrument **100**. As such, an electrical current can be provided from RF generator connector **112** to the bipolar electrode assembly **120** through electrical leads **114**. Electrical leads **114** extend from RF generator connector **112** through extension tube **108**A. The electrical leads **114** pass through the catheter hub, or bifurcation, **108**B and enter the catheter main shaft **108** of the surgical instrument **100**. The electrical leads **114** pass through the catheter main shaft **108** which extends through body **101** of surgical instrument **100** and terminate at bipolar electrode assembly **120**. As can be seen in FIGS. **1** and **2**, and as will be described further later in this specification, electrical leads **114** consist of a first lead **114**A and second lead **114**B. As such, in accordance with well-known principles, the bipolar electrode assembly **120**, when energized by an electrical current through leads **114**, provides hemostatic therapy to a patient

Irrigation assembly **130** includes an irrigation hub **132**. Irrigation hub **132** is attached to catheter main shaft **108**, which passes through catheter hub **108**B. Irrigation hub **132** is provided to attach to an irrigation pump (not shown in FIG. **1**). The irrigation pump would provide fluid to irrigation hub **132** where the fluid would pass through the catheter main shaft **108** through the length of surgical instrument **100**. The fluid passes through a central lumen **121** (not visible in FIG. **1**) that is included in bipolar electrode assembly **120** to be delivered to a site within the body of a patient. Thus, through irrigation assembly **130**, fluid to irrigate a site within a patient's body can be provided by surgical instrument **100**.

The electrical leads **114** of the bipolar hemostat assembly **110** and the irrigation fluid provided by the irrigation assembly **130** both pass through the catheter main shaft **108**. As such, the electrical leads **114** are insulated conductors such that they are electrically isolated from the irrigation fluid that is carried through catheter main shaft **108**.

Catheter hub, or bifurcation, **108**B contains an internal seal that is provided to prevent irrigation fluid from the irrigation assembly **130** from traveling proximally along surgical instrument **100** through extension tube **108**A. Thus, irrigation fluid is able to pass through catheter main shaft **108**, however, the irrigation fluid is not able to "back flow" through extension tube **108**A and contact RF connector **112**.

The multi-function surgical instrument **100** also contains needle assembly **150**. Needle assembly **150** includes an injection needle **152** and is utilized to inject a fluid into a site within the patient's body. As can be seen in FIG. **1**, needle assembly **150** includes injection needle **152**, needle hub **151**, and needle operator **156**. Injection needle **152** extends at its proximal end from needle hub **151** through body **101** of surgical instrument **100**. Needle **152** extends through catheter main shaft **108** and is received within the central lumen **121** of the bipolar electrode assembly **120**. Needle operator **156** is utilized to provide injection fluid to needle assembly **150** for delivery to the patient through needle **152**. Needle hub **151**, which carries needle **152** at its distal end, is slidably mounted within body **101** of surgical instrument **100** such that needle **152** may be moved distally through bipolar electrode assembly **120** such that the injection needle tip **154** extends externally from the bipolar electrode assembly **120**. Needle hub **151** is also able to be moved in a proximal direction with respect to body **101** such that injection needle tip **154** is able to be retracted within lumen **121** of bipolar electrode assembly **120**. The user of surgical instrument **100** is able to grip needle hub **151** at the needle operator **156** in order to move needle assembly **150** both distally and proximally along body **101**.

Body **101** contains a seal that surrounds catheter main shaft **108**, which passes therethrough. Needle **152**, as it passes through body **101**, penetrates the seal that surrounds the main shaft **108** and the wall of the main shaft **108** to extend through main shaft **108** to the distal end **104** of surgical instrument **100**. The seal is provided in body **101** and around main shaft **108** to prevent the irrigation fluid that is also carried in main shaft **108** from exiting the shaft and body **101** at the location where needle **152** penetrates the main shaft **108**. Body **101** also includes strain relief members **109**. Strain relief members **109** are disposed on body **101** and are used to attach catheter **108** to body **101** at the proximal and distal ends of body **101**.

FIG. **2** provides a more detailed view of the distal end **104** of the surgical instrument **100** so that the configuration of the injection needle **152**, electrical leads **114**A, **114**B, and bipolar electrode assembly **120** can be more clearly seen. In order to provide this more detailed view of the distal end **104** of the surgical instrument **100**, a portion of main shaft **108** has been cut away such that the components referred to above may be more clearly visualized.

As can be seen in FIG. **2**, bipolar electrode assembly **120** consist of a cylindrical body portion **126**, a hemispherical distal end tip **127** and a shank portion **128**. Discrete spiral electrodes **129**A and **129**B are disposed on the outer surface of the cylindrical body portion **126** and the hemispherical distal end tip **127**. Each of the spiral electrodes **129**A and **129**B connect to one of the electrical leads **114**A and **114**B.

As can be visualized in FIG. **2**, bipolar electrode assembly **120** contains a lumen **121** that extends centrally and axially therethrough and which receives injection needle **152** within it. As can be seen in FIG. **2**, injection needle tip **154** has been extended from bipolar electrode assembly **120**. Bipolar electrode assembly **120** is a gold plated ceramic tip and each electrical lead **114**A and **114**B is connected to a different one of the spiral electrodes **129**A, **129**B with a conductive epoxy.

As can be further seen in FIG. **2**, injection needle **152** extends through catheter **108** and may be comprised of two portions. In the embodiment of FIG. **2**, injection needle **152** consists of a **22** gauge hypotube **152**A into which is welded a 25 gauge needle **152**B at the distal end **152**AA of the hypotube **152**A. The 25 gauge needle **152**B is received within a guide tube **190** which extends proximally from shank portion **128** of the bipolar electrode assembly **120**. Guide tube **190** defines a lumen which is axially aligned with lumen **121** that is included in bipolar electrode assembly **120**. Guide tube **190** serves to guide injection needle **152** into the bipolar electrode assembly **120** and also acts as a positive stop which allows for the needle to only extend a predetermined length beyond the hemispherical distal end tip **127** of bipolar electrode assembly **120**. This stop feature is accomplished by utilizing the structures of the distal end **152**AA of hypotube **152**A and the proximal end **190**A of guide tube **190**. As can be understood, as injection needle **152** is moved distally within catheter **108** and is received within guide tube **190**, eventually the distal end **152**AA of hypotube **152**A will abut the proximal end **190**A of guide tube **190** such that the injection needle **152** can not be inserted any further within guide tube **190**. This interaction of the hypotube **152**A and the guide tube **190** serves as a positive stop for limiting the distance that injection needle **152** can be extended from the surgical instrument **100**.

As can be also seen in FIG. **2**, guide tube **190** also includes a plurality of holes **192** that extend completely through the wall structure of guide tube **190**. The purpose of the holes **192** in guide tube **190** is to permit the irrigation fluid that is carried through catheter **108** to flow through the guide tube from outside of the guide tube such that it is able to enter and pass through lumen **121** in bipolar electrode assembly **120** for delivery to the body of the patient. The guide tube **190** can be attached to the bipolar electrode assembly **120** through any of a variety of methods, one of which is by utilizing an epoxy to secure the tube to the electrode assembly.

A multi-function surgical instrument that includes a hemostat capability, an irrigation capability, and an injection needle capability is disclosed in U.S. Pat. Nos. 5,336,222 and 5,522,815 and the two above-referenced patents are incorporated herein in their entirety.

In returning to FIGS. **1** and **2**, it can also be seen that multi-function surgical instrument **100** includes a snare device **170**. As will be described in more detail later in this specification, snare **170** is directly attached to injection needle **152** and can be extended from, and retracted into, bipolar electrode assembly **120** by moving needle **152** distally and proximally, respectively, within bipolar electrode assembly **120**. Snare **170** includes a snare loop **172** that can be deployed in an operative configuration when the injection needle **152** has been extended from bipolar electrode assembly **120**. The snare loop **172** can be retracted into the bipolar electrode assembly **120** by retracting needle **152** within the bipolar electrode assembly **120**. Thus, the operation of snare **170** is controlled by the operator through movement of needle assembly **150**. Since the snare **170** is directly attached to injection needle **152**, as the injection needle is extended from the bipolar electrode assembly **120** the snare loop **172** will be deployed from the bipolar electrode assembly **120** and as the needle **152** is retracted into the bipolar electrode assembly **120** the snare loop **172** will also be retracted within the bipolar electrode assembly **120**.

Snare **170** is utilized to perform a procedure on a patient in accordance with well-known principles. For example, a polyp that is to be removed from a patient can be captured within snare loop **172**. As such, snare **170** can be either an electrically energized snare or a non-electrical snare. With either embodiment, snare **170** can be utilized to capture tissue within the body of a patient.

FIGS. **1** and **2** illustrate snare **170** as a monopolar snare wire. As such, a snare electrical connector **174** is provided at the proximal end **102** of surgical instrument **100** on needle operator **156**. An electrical lead (not visible) extends from snare electrical connector **174** to snare loop **172** to carry an electrical current from an RF generator (not shown) through electrical connector **174** to snare loop **172**. The electrical lead passes from electrical connector **174** to snare loop **172** through catheter main shaft **108** and thus is insulated such that it is electrically isolated from the irrigation fluid that also passes through catheter main shaft **108**.

FIGS. **1** and **2** illustrate snare **170** in a first position where snare loop **172** has been deployed from the bipolar electrode assembly **120**. As such, needle hub **151** has been moved distally along body portion **101** of the surgical instrument **100**. Since the snare is directly attached to the injection needle **152**, this distal movement of needle hub **151** will deploy snare loop **172** from the bipolar electrode assembly **120**.

FIG. **3** illustrates a configuration for the attachment between snare **170** and injection needle **152**. As can be seen, snare **170** is comprised of a snare loop **172** and a snare attachment portion **174**. In the configuration of FIG. **3**, snare loop **172** is an elliptical-shaped loop, however, as will be explained further later in this specification, snare loop **172** can be formed in any of a variety of different geometric shapes. Attachment portion **174** is utilized to attach snare **170** to injection needle **152**. The attachment of snare **170** to injection needle **152** extends from attachment point **176** at a distal end of injection needle **152** in a proximal direction along injection needle **152**. Attachment point **176** is located a sufficient distance in a proximal direction from needle tip **154** such that the snare loop **172** does not impede the use of needle tip **154** for injecting fluid into the body of a patient. The distance between the distal end of the needle tip **154** and attachment point **176** is not rigidly defined, however, as described above, the distance is sufficient to permit operation of both the snare **170** and the injection needle **152**. Additionally, the attachment portion **174** of snare **170** can extend any distance along injection needle **152**. A design consideration in determining the length of attachment portion **174** is to provide sufficient strength for the attachment between snare **170** and injection needle **152** such that snare **170** can be utilized for its intended purposes without detaching from injection needle **152**.

As discussed previously, snare **170** can either be an electrically energized snare or a non-energized snare and, as such, snare **170** can be manufactured from a variety of materials. For example, snare **170** can be manufactured from

Nitinol, stainless steel or other metals, composites, or rigid polymers. The snare loop may be either a single strand wire or a multi-stranded, braided, or twisted wire. Likewise, injection needle **152** may be manufactured from a variety of materials including metals or plastics. As such, the method of attachment between snare **170** and injection needle **152** is in-part dependent upon the materials that are utilized to form snare **170** and injection needle **152**. However, the present invention is not limited to any particular method of attaching snare **170** to injection needle **152**. As discussed above, depending upon the materials that are utilized to manufacture each of the snare **170** and injection needle **152**, the snare **170** could be attached to needle **152** through soldering, welding, swaging, crimping, or by utilizing an adhesive.

FIGS. **4** and **5** illustrate surgical instrument **100** in a second position where snare **170** has been retracted within bipolar electrode assembly **120**. As can be seen, needle hub **151** has now been moved proximally along body **101** of surgical instrument **100**. This proximal movement of needle hub **151** will also move needle **152** proximally within catheter main shaft **108** which will retract injection needle tip **154** within bipolar electrode assembly **120**. Again, since snare **170** is attached to injection needle **152**, retraction of injection needle **152** within bipolar electrode assembly **120** will also retract snare loop **172** of snare **170** within the bipolar electrode assembly such that the snare loop **172** is not now in an operative position at the distal end **104** of surgical instrument **100**.

As can be seen in greater detail in FIG. **5**, the retraction of injection needle **152** has caused snare loop **172** to collapse and be received within lumen **121** of bipolar electrode assembly **120**. It is understood that injection needle **152** must be retracted within bipolar electrode assembly **120** a sufficient distance if snare loop **172** is to be entirely received within lumen **121** of the bipolar electrode assembly **120**.

As was mentioned previously, snare loop **172** of snare **170** can be formed in any of a variety of geometric configurations. FIGS. **6–10** illustrate several of the alternative embodiments for the geometric configuration for the snare loop of the present invention. As can be seen in FIG. **6**, snare loop **172A** is configured in a four-sided diamond-shaped configuration. Attachment portion **174A** extends from the snare loop **172A** for attachment to an injection needle as described previously. FIG. **7** illustrates a circular snare loop **172B** attached to a snare attachment portion **174B**. FIGS. **8**, **9**, and **10** illustrate triangular snare loop **172C**, an octagonally-configured snare loop **172D**, and a six-sided snare loop **172E**, respectively. Snare loops **172C**, **172D**, and **172E** are formed with snare attachment portions **174C**, **174D**, and **174E**, respectively. As was mentioned previously for elliptical snare loop **172** for snare **170**, the snare loops and snare attachment portions illustrated in FIGS. **6–10** may be formed from any of a variety of materials previously described and contemplated by those skilled in the art and may be attached to an injection needle by any of the methods previously described or by any method contemplated by one skilled in the art.

FIG. **11** illustrates an embodiment for the multi-function surgical instrument **100** where the needle hub **151** can be prevented from rotation about its longitudinal axis within body **101** of the surgical instrument **100**. Surgical instrument **100**, as illustrated in FIGS. **11** and **12**, does not show the bipolar hemostat assembly **110**, irrigation assembly **130**, and snare **170** as discussed previously, however, those assemblies could be incorporated into the embodiment of the instruments of FIGS. **11** and **12** and their illustration is not required for purposes of describing the features to be discussed in FIGS. **11** and **12**.

As mentioned above, the embodiment of surgical tool **100** in FIG. **11** is capable of preventing rotation of needle hub **151**. As such, needle hub **151** includes anti-rotation structure **151** A at a distal end **153** of needle hub **151**. The anti-rotation structure **151** A is a flat, planar member that is formed in either a square or rectangular shape. This structure is received within needle hub receiving structure **101A** which is included on body **101** of the surgical instrument **100**. As the needle hub **151** is moved distally along body **101** in order to extend the injection needle from the distal end of the surgical instrument, the anti-rotation structure **151** A is received within the needle hub receiving structure **101** A. As can be understood, when the anti-rotation structure **151** A is received within the needle hub receiving structure **101A**, due to the complimentary structural configuration of the two structures, the needle hub **151** is not able to be rotated when it is in this position on body **101**.

FIG. **12** illustrates an embodiment for surgical instrument **100** where the needle hub **151** is able to be rotated about its longitudinal axis within body **101**. In order to provide for rotation of needle hub **151** within body **101**, a structure **151B** with rounded edges is provided at the distal end **153** of needle hub **151**. When the rounded structure **151** B is received within needle hub receiving structure **101** A, because it has rounded corners, the needle hub **151** may be rotated even when it is in its distal-most position on body **101**. It may be desirable to provide for rotation of needle hub **151** so that the physician utilizing the surgical instrument **100** may position injection needle **152** and snare **170**, which would be attached to needle **152** as described previously, into any position that may be helpful to the surgeon in performing a procedure with the surgical instrument.

It has been described previously that an injection needle could be provided within surgical instrument **100** such that an injection capability was provided to surgical instrument **100**. As was also described previously, a snare could be attached to the distal end of the injection needle to provide a snare capability to the surgical instrument. However, it is not required that a needle be utilized with a surgical instrument in order to provide a snare capability to the surgical instrument. FIGS. **13** and **14** illustrate an embodiment for a multi-function surgical instrument **200** that has a hemostat capability, an irrigation capability and a snare capability, without requiring an injection capability.

As can be seen in FIG. **13**, multi-function surgical instrument **200** includes a bipolar hemostat assembly **210** and an irrigation assembly **230**, which operate in accordance with the principles described previously for the embodiment of surgical instrument **100**. FIG. **13** also illustrates a snare **270** that is included in surgical instrument **200**. However, in the embodiment of FIGS. **13** and **14** for surgical instrument **200**, snare **270** is not attached to an injection needle, but rather, is attached to the distal end of an attachment member (not visible in FIGS. **13** and **14**) that extends through body **201** of surgical instrument **200** and through catheter **208**. The attachment member extends through a central lumen that is included in the bipolar electrode assembly **220**, as was described previously for the bipolar electrode assembly **120** in the embodiment of FIG. **1**

As can be seen in FIGS. **15** and **16**, snare **270** is attached to attachment member, or support member or shaft, **280** at the distal end of shaft **280**. As such, snare loop **272** of snare **270** can be extended from, and retracted into, bipolar electrode assembly **220** by a user gripping operator **278** and moving the attachment member **280** within catheter **208** of surgical tool **200**. Thus, adding the functionality of a snare device to a multi-function surgical instrument is not dependent upon including an injection capability in the surgical instrument. The surgical instrument **200** can be provided with a rod or attachment member that extends through the catheter **208** which includes the snare **270** attached at its distal end. By retracting the distal end of the attachment member **280** within the bipolar electrode assembly **220**, the snare loop **272** of snare **270** would also be retracted into bipolar electrode assembly **220**. By extending attachment member **280** distally from bipolar electrode assembly **220**, the snare loop **272** of snare **270** is deployed from the distal end of surgical instrument **200**.

FIGS. **15** and **16** illustrate the attachment of snare **270** to attachment member, or shaft, **280**. In the embodiment of FIGS. **15** and **16**, shaft **280** is illustrated as a hypotube. In FIG. **15**, shaft attachment portion **274** of snare **270** has been inserted into shaft **280** and in FIG. **16** shaft attachment portion **274** has been attached to the outer circumference of shaft **280**. Snare **270** can be fixed to shaft **280** by utilizing any of a variety of attachment methods and snare **270** and shaft **280** can be formed from any of a variety of materials. For example, snare **270** could be joined to shaft **280** by soldering, welding, swaging, crimping, or utilizing an adhesive. Additionally, snare loop **272** of snare **270** can be configured in any of the geometric shapes as was described previously in FIGS. **6–10**.

FIGS. **17** and **18** illustrate an embodiment for multi-function surgical instrument **200**, which includes a shaft **280** within it, where a grasper/forceps device has been attached to the distal end of the shaft **280**. Therefore, in this embodiment for surgical instrument **200**, the snare loop capability has been exchanged for a grasper/forceps capability. The grasper/forceps **370** is attached to the distal end of shaft **280** and thus is able to be extended from, and retracted into, bipolar electrode assembly **220** through movement of shaft **280** within catheter **208**.

The grasper/forceps device **370**, as was previously described for snare **270**, can be attached to the distal end of shaft **280** through any of a variety of methods and the present invention is not limited to any particular method of attachment between grasper/forceps **370** and shaft **280**. All that is required is that grasper/forceps **370** be attached to shaft **280** such that as shaft **280** is withdrawn into bipolar electrode assembly **220**, the grasper/forceps **370** is also retracted within bipolar electrode assembly **220**. As the grasper/forceps **370** is retracted into the bipolar electrode assembly **220**, the engagement of the fingers **372** of the grasper/forceps **370** with the structure defining the lumen in bipolar electrode assembly **220** will collapse the fingers **372** and converge the fingers **372** together such that they are able to grasp tissue within the body of a patient.

As was discussed previously, where the snare loop could be configured in any of a variety of geometric shapes, the grasper/forceps **370** can also be formed in a variety of different configurations. FIGS. **19–24** illustrate several of the different configurations that could be utilized for grasper/forceps **370**. As can be seen in FIG. **19**, grasper/forceps **370** is comprised of three fingers **372**. Each finger **372** includes a hook **374** at the distal end of the finger. The hook is provided to provide additional grasping capability to the grasper/forceps **370**. FIGS. **20–24** provide front views of several of the various alternative configurations that could be utilized for the grasper/forceps **370**. FIGS. **20–24** illustrate configurations **370**A through **370**E, respectively, for the grasper forceps **370**. As can be seen, the grasper/forceps **370** can include any number of fingers with any relative positioning of the fingers within the grasper/forceps **370**.

FIGS. **25** through **36** illustrate several additional embodiments for the surgical instrument of the present invention. As illustrated, other surgical tools could be included in the surgical instrument to provide additional capabilities to the multifunction surgical instrument **200**.

As is illustrated in FIGS. **25** and **26**, a scraper/forceps device **470** is attached to the distal end of shaft **280**. Again, the scraper/forceps **470** would be extended from bipolar electrode assembly **220** by distally moving shaft **280** within catheter **208** and scraper/forceps **470** would be retracted into the bipolar electrode assembly by proximally moving shaft **280** within catheter **208**. Again, the scraper/forceps **470** could be manufactured from any of a variety of materials and can be attached to shaft **280** by any of a variety of attachment methods.

Additionally, scraper/forceps **470** can be configured in any of a variety of physical configurations. FIGS. **27** and **28** illustrate a first possible configuration for a scraper/forceps device. As can be seen in FIGS. **27** and **28**, scraper/forceps **470**A is comprised of a single finger **472**A which includes a scraper portion **474**A at its distal end. FIGS. **29** and **30** illustrate a second possible configuration for the scraper/forceps and illustrates the scraper/forceps **470**B as a single, elongated, cylindrical structure. FIGS. **31** and **32** illustrate a third possible configuration for a scraper/forceps device. In the embodiment of FIGS. **31** and **32**, scraper/forceps **470**C is comprised of a first finger **472**C and a second finger **473**C. First finger **472**C includes a scraper portion **474**C at its distal end and second finger **473**C includes a scraper portion **475**C at its distal end. FIGS. **33** and **34** illustrate a fourth possible configuration for a scraper/forceps device where scraper/forceps **470**D is comprised of four fingers, namely fingers **472**D, **473**D, **474**D, and **475**D. Each finger includes a scraper portion at a distal end thereof.

FIG. **35** illustrates an embodiment for surgical instrument **200** where a retrieval basket **570** has been attached to the distal end of shaft **280**. The retrieval basket can be formed in any of a variety of configurations and would be retracted into, and extended from, bipolar electrode assembly **220** through movement of shaft **280** as previously described. Retrieval basket **570** could be utilized in accordance with well-known principles to capture a foreign body from within the body of a patient. The combination bipolar electrode assembly **220** and retrieval basket **570** would provide a single device to control bleeding from a foreign body while using the basket to remove the foreign body. Another use would be polyp or tissue retrieval after polypectomy or mucosectomy when the bipolar electrode assembly is used to treat post-procedural bleeding. The basket can also assist in adherent clot removal prior to cautery.

FIG. **36** illustrates an embodiment for surgical instrument **200** where a cytology brush **670** has been attached to the distal end of shaft **280**. The cytology brush **670** would be used in accordance with well-known principals, e.g., for sampling for H. Pylori before or after ulcer cautery.

FIG. **37** illustrates an embodiment for the multi-function surgical instrument where a balloon **770** has been added to the outside diameter of the catheter main shaft **208**. The balloon **770** is disposed on the outside diameter of the catheter **208** and in a proximal direction with respect to bipolar electrode assembly **220**. In order to provide for inflation and deflation of balloon **770**, a balloon hub **772**, as illustrated in FIG. **38**, would be provided at the proximal end of the surgical instrument and could be provided as an extrusion off of the catheter main shaft **208**. A lumen could be provided from the balloon hub **772**, either through the main catheter shaft **208** or external to the main catheter shaft **208**, to extend to balloon **770** for inflation and deflation of balloon **770**. It should be understood that a balloon device **770** as illustrated in FIG. **37** could be utilized with any of the other previously discussed embodiments for the multi-function surgical instrument.

FIG. **39** illustrates an embodiment for surgical instrument **200** where shaft **280** is a hollow, tubular structure and comprises a cryotherapy tube. The cryotherapy tube **870** extends through the lumen included in bipolar electrode assembly **220** and can be used to provide any of a variety of different gases **875**, e.g., nitrous oxide, liquid nitrogen, or other gases for freezing and ablating tissue, within the body of the patient. The cryotherapy tube **870** can be extended from the bipolar electrode assembly **220** and retracted into the bipolar electrode assembly **220**.

The above-described embodiments illustrate that a variety of different surgical tools can be incorporated into the multi-function surgical instrument of the present invention. Whereas a variety of these different types of surgical tools have been described, it can be contemplated that the multi-function surgical instrument can include any of a variety of other surgical tools. The additional surgical tools could be attached to either an injection needle assembly or an attachment member as was described herein. Thus, the present invention is not limited to only incorporating the tools as described herein in the multi-function surgical instrument. It is evident that one skilled in the art could contemplate other surgical tools being incorporated into the multi-function surgical instrument of the present invention and the teachings of the present invention could be utilized to implement these tools in the surgical instrument.

Additionally, it is not required that the hemostat assembly be a bipolar hemostat. The present invention can be practiced with a monopolar hemostat. The monopolar hemostat would include an aperture that would extend axially therethrough and which would accommodate a surgical tool within it.

As discussed above, the disclosed embodiments are illustrative of the various ways in which the present invention may be practiced. Other embodiments can be implemented by those skilled in the art without departing from the spirit and scope of the present invention.

What is claimed is:

1. A multi-function surgical instrument comprising:

a catheter;

a bipolar hemostat assembly, said bipolar hemostat assembly including an electrical connector at a proximal end, a bipolar electrode assembly at a distal end, and first and second electrical leads extending from said proximal end to said distal end and disposed within said catheter and wherein said bipolar electrode assembly includes an aperture extending axially therethrough;

a cryotherapy tube carrying a cryotherapy fluid, said cryotherapy tube disposed within said catheter and having a proximal end and a distal end, said distal end movable within said aperture of said bipolar electrode assembly between a first position wherein said distal end is extended from said bipolar electrode assembly and a second position wherein said distal end is retracted within said bipolar electrode assembly.

2. The multi-function surgical instrument of claim **1** wherein the cryotherapy tube is adapted to withstand temperatures of the cryotherapy fluid.

3. A multi-function surgical instrument system comprising:

a catheter;

a bipolar hemostat assembly, said bipolar hemostat assembly including an electrical connector at a proximal end, a bipolar electrode assembly at a distal end, and first and second electrical leads extending from said proximal end to said distal end and disposed within said catheter and wherein said bipolar electrode assembly includes an aperture extending axially therethrough;

a cryotherapy tube, said cryotherapy tube disposed within said catheter and having a proximal end and a distal end, said distal end movable within said aperture of said bipolar electrode assembly between a first position wherein said distal end is extended from said bipolar electrode assembly and a second position wherein said distal end is retracted within said bipolar electrode assembly; and

a cryotherapy fluid source in fluid communication with the cryotherapy tube.

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